CROWLEY MARINE SERVICES, INC.

May 16, 1995

Dr. Dave Kendall
Dredged Material Management Office
US Army Corps of Engineers
Seattle District
PO Box 3755
Seattle, Washington 98124-2255

Reference: **PSDDA Sediment Characterization Sampling and Analysis Plan, Slip No. 4, Seattle**

Dear Dr. Kendall:

Enclosed please find one unbound and four bound copies of the PSDDA sediment characterization sampling and analysis plan for Slip No. 4 in Seattle for your review and distribution.

Please contact me at (206) 442-8042 with any questions you have regarding this report.

Sincerely,

Stephen Wilson
Manager, Environmental Compliance

Encl.

cc: Slip No. 4 Corr. w/o encl.
Jim Van der Veen w/o encl.

95-2-00537

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PSDDA Sediment Characterization Sampling and Analysis Plan

Crowley's 8th Avenue Terminal Facility
Seattle, Washington

Prepared for

Crowley Marine Services
2401 4th Avenue
Seattle, Washington 98111

PTI Contract C483-06-02

May 1995

permit app. 95-2-00537

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ACRONYMS AND ABBREVIATIONS

BT	bioaccumulation trigger
Corps	U.S. Army Corps of Engineers
Crowley	Crowley Marine Services, Inc.
DAIS	Dredged Analysis Information System
DMMU	Dredged Material Management Unit
IDCS	impact-driven coring system
ML	maximum level
MLLW	mean lower low water
PCB	polychlorinated biphenyl
PSDDA	Puget Sound Dredged Disposal Analysis
PSEP	Puget Sound Estuary Program
PTI	PTI Environmental Services
QA/QC	quality assurance and quality control
SAP	sampling and analysis plan
SL	screening level
TOC	total organic carbon
TVS	total volatile solids

1. INTRODUCTION

1.1 PROJECT DESCRIPTION

Crowley Marine Services, Inc. (Crowley) proposes to conduct maintenance dredging in the outer portion of Slip No. 4 on the Duwamish River in Seattle, Washington (see vicinity and location maps, Figures 1 and 2), to provide continued access for oceangoing barges and tugboats. This project includes the dredging of a mooring basin for oceangoing barges along the western side of Slip No. 4 to a design depth of 17 ft below mean lower low water (−17 ft MLLW) (see Figure 3).

A bathymetric survey of Slip No. 4 in August 1994 indicated that bottom depths within the area proposed for dredging range from approximately −9 to −15 ft MLLW, with the majority of the bottom depths between −12 and −14 ft MLLW (see Figure 3). In anticipation of the proposed maintenance dredging of Slip No. 4, the volume of sediments lying above an assumed dredging depth of −17 ft MLLW was estimated. The assumption was made that the dredging would extend approximately 125 ft in a direction perpendicular to the dock along the middle berth and include the area at the mouth of the slip extending to the property line (see Figure 3 for assumed dredging limits). For this preliminary volume estimate, side slopes along the edges of the area to be dredged were not included in the calculations. A design dredging depth of −17 ft MLLW would entail the removal of approximately 2–5 ft of sediments over most of the area. The volume of sediments lying above the assumed dredged horizon within the area to be dredged was estimated to be 12,080 yd^3. With allowance for side slopes, the volume of dredged material was estimated to be approximately 13,000 yd^3.

Dredging will be conducted using a clamshell dredge and barge. Depending on the results of the Puget Sound Dredged Disposal Analysis (PSDDA) program sediment characterization proposed in this sampling and analysis plan (SAP), sediments will be disposed of either at the PSDDA unconfined, open-water disposal site in Elliott Bay by a bottom-dump barge or at a suitable upland or nearshore location (to be identified later in the event it is needed) by offloading the sediment from the barge and transporting by truck.

1.2 SEDIMENT DESCRIPTION

A pilot sediment characterization study was conducted for Slip No. 4 in April 1994 (PTI 1995). Surficial sediments (0–2 cm) were sampled from four stations in Slip No. 4 (see Figure 4) to provide a general characterization of sediment conditions and a preliminary assessment of the likely suitability of the sediments for disposal at a PSDDA site.

Sediments were analyzed for selected semivolatile organic compounds, organochlorine pesticides, polychlorinated biphenyls (PCBs), selected metals (i.e., antimony, arsenic, cadmium, chromium, copper, lead, mercury, silver, and zinc), total organic carbon (TOC), and grain-size distribution.

Surficial sediment characteristics at the four stations, three of which are within the area proposed for dredging, were compared with applicable PSDDA criteria (Table 1). This comparison resulted in the following conclusions:

1. The concentrations of certain chemicals in the surficial sediments at all four stations exceeded PSDDA screening levels (SLs). Dredged sediments with chemical concentrations exceeding these SLs would require biological testing (i.e., sediment toxicity tests) to determine the suitability of those sediments for disposal at an unconfined, open-water site.

2. None of the chemical concentrations in the surficial sediments at these four stations exceeded PSDDA maximum levels (MLs) (such exceedances in dredged sediments proposed for disposal at an unconfined, open-water site would normally indicate that the sediments would be unsuitable for such disposal).

3. Compositing the sediments over the depth to be dredged (e.g., 4 ft), as required for PSDDA testing, could potentially reduce the concentrations of chemicals below those found in surficial sediments. Some exceedances of PSDDA SLs are still likely to occur in the composite sediment samples. It is therefore likely that biological testing of the sediments proposed for dredging and disposal at an unconfined, open-water site will be required.

These results were considered in designing the proposed study of bulk sediment characteristics for PSDDA evaluation purposes and were the reason why tiered testing is not being proposed. Instead, considering the high likelihood that one or more chemicals in the bulk sediment samples will exceed PSDDA SLs, concurrent chemical analyses and toxicity testing are proposed.

1.3 EELGRASS/KELP BEDS

There are no eelgrass or kelp beds in the vicinity of the project.

1.4 SITE HISTORY

The upland portion of the 8th Avenue Terminal site was used for a variety of industrial purposes prior to its development as a dock and berthing facility in the early 1980s. Currently, the upland portion of the 8th Avenue Terminal facility is used for storage of cargo containers prior to loading onto oceangoing barges. The land on the northeast

shore of Slip No. 4 is vacant, while the land on the southeast shore of Slip No. 4 is occupied by a Boeing parking lot. Several storm drains serving areas to the east of East Marginal Way South, including Boeing Field, discharge to the head of Slip No. 4. A combined sewer overflow also discharges to the head of the slip.

It is known that Slip No. 4 is a remnant of the original course of the Duwamish River that existed prior to dredging and channelization of the river. No records have been found of dredging in the slip prior to 1980. In May 1980, Marine Power & Equipment Company, Inc., of Seattle applied to the U.S. Army Corps of Engineers (Corps) for a permit to dredge approximately 85,000 yd^3 of sandy silt from the western side of Slip No. 4 on the Duwamish River. This dredging project was part of the development of the present dock and berthing facility now occupied by Crowley's 8th Avenue Terminal. Cross sections of the slip prior to that dredging project indicate that the maximum depth was approximately −3 ft MLLW. The design depth for the dredging project was −15 ft MLLW. A dredging permit was authorized by the Corps on January 27, 1981. The project was completed using a clamshell dredge sometime prior to April 10, 1981, at which time a post-dredging inspection verified a dredged depth of −15.2 ft MLLW. The dredged material was hauled away from Slip No. 4 by barge and disposed of in open water at the 4-Mile Rock disposal site in Elliott Bay. The post-dredging inspection verified that all work was completed within the terms of the permit. A dock was then constructed along the western shore of Slip No. 4, extending out over a rip-rapped bank.

1.5 PERMITTING

A permit application for Slip No. 4 dredging and disposal was submitted by Crowley to the Corps, Seattle District, in April 1995 (File No. 95-2-00537, see Appendix A). Required permitting actions include a Corps Section 10/404 permit, State of Washington Hydraulic Project Approval and Section 401 Water Quality Certification, City of Seattle Shoreline Development Permit, and a Washington Department of Natural Resources Open-Water Disposal Site Use Permit. Designation of an acceptable disposal site based on results of the sediment characterization proposed herein is a critical remaining element prior to final project design and permit issuance.

2. PROGRAM OBJECTIVES AND CONSTRAINTS

The sediment characterization program objectives and constraints are summarized below:

- to characterize sediments to be dredged in conformance with PSDDA testing requirements to enable the PSDDA agencies to evaluate the open-water disposal option;
- to identify discrete Dredged Material Management Units (DMMUs) so that their acceptability for disposal at a PSDDA site can be evaluated independently of one another, while ensuring that any sediments within DMMU(s) found to be unacceptable for such disposal can instead be disposed of at an approved upland or nearshore site;
- to collect, handle, and analyze representative sediment samples in accordance with protocols and quality assurance and quality control (QA/QC) requirements outlined in the PSDDA Evaluation Procedures Technical Appendix (PSDDA 1988), the updated procedures documented in Chapter 5 and Appendix A of the PSDDA Phase II Management Plan Report (PSDDA 1989), modifications made through the PSDDA annual review process, and procedures presented in the Puget Sound Estuary Program (PSEP) recommended Protocols for Measuring Selected Environmental Variables in Puget Sound (PSEP 1991);
- to sample sediments within Slip No. 4 during the summer of 1995, with the characterization and permitting processes completed by November 1995 to allow dredging and disposal to occur during the winter of 1995-1996.

3. PROJECT TEAM AND RESPONSIBILITIES

The sediment characterization program will include 1) project planning and agency coordination, 2) field sample collection, 3) laboratory preparation and analysis, 4) QA/QC management, and 5) final data report preparation. Staffing and responsibilities are outlined below.

3.1 PROJECT PLANNING AND COORDINATION

Mr. Stephen Wilson, Crowley Marine Services, Seattle, Washington, will be the overall project manager responsible for overseeing the sediment characterization program. As Crowley's principal representative, he will also be the primary contact for PSDDA agencies. Dr. Lawrence McCrone, PTI Environmental Services (PTI), Bellevue, Washington, will assist Mr. Wilson in technical matters pertaining to the sediment characterization program and its relationship to dredging and disposal methods. Following approval of the SAP by the PSDDA agencies, Dr. McCrone will be responsible for coordinating and monitoring administrative activities to ensure timely and successful completion of the project. Dr. McCrone will provide a copy of the approved SAP, along with the PSDDA agency approval letter, to all sampling and testing subcontractors. Any significant deviation from the approved SAP will be coordinated with the Dredged Material Management Office of the Corps.

3.2 FIELD SAMPLE COLLECTION

Ms. Jane Sexton of PTI will oversee the logistics and personnel assignments of the field sampling and laboratory analysis programs. Ms. Sexton will also be responsible for field documentation procedures and physical evaluation and logging of the samples. Dr. Chip Hogue of PTI will supervise field collection of the sediment samples in Slip No. 4 and act as PTI's chief scientist onboard the sampling vessel. Dr. Hogue will also be responsible for ensuring accurate station positioning; recording sample locations, depths, and identification; and ensuring conformance with sampling and handling requirements. Ms. Sexton will serve as chief scientist, with similar responsibilities for the field collection of reference sediments from Carr Inlet. If a significant deviation from this SAP is being considered because of conditions encountered during sampling, Dr. Hogue or Ms. Sexton will notify Dr. McCrone, the PTI project manager, and Mr. Wilson, the Crowley project manager. If possible, the PTI project manager will consult with staff at the Corps prior to deviating from the procedures in this SAP.

3.3 LABORATORY PREPARATION AND ANALYSES

The sediment samples will be physically evaluated, composited, and placed in appropriate sample containers by Ms. Jane Sexton or Mr. Arthur Burden, a field technician at PTI. Appropriate protocols for decontamination, sample preservation, and holding times will be observed. Ms. Sexton will be responsible for documenting sample preparation, recording observations, and ensuring chain-of-custody up until the time the samples are delivered for analysis to the laboratories.

Mr. James McAteer, a chemist at PTI, will be responsible for coordinating the physical and chemical analyses, which will be performed by Columbia Analytical Services, Inc. of Kelso, Washington, and Analytical Resources, Inc. of Seattle, Washington. Mr. McAteer will ensure that the samples submitted to the analytical laboratories are in accordance with PSDDA analytical testing protocols and QA/QC requirements. A written report of analytical results and QA/QC procedures will be prepared by the analytical testing laboratories and will be included as an appendix in the final report.

Ms. Jane Sexton will be responsible for coordinating the sediment toxicity tests, which will be performed by Northwestern Aquatic Sciences of Newport, Oregon. Ms. Sexton will ensure that the samples submitted to the toxicity testing laboratory are in accordance with PSDDA testing protocols and QA/QC requirements. A written report for the toxicity test results and QA/QC procedures will be prepared by the toxicity testing laboratory and will be included as an appendix in the final report.

3.4 QA/QC MANAGEMENT

Ms. Jane Sexton and Mr. James McAteer will serve as Quality Assurance Representatives for the sediment characterization program. Ms. Sexton will record and correct any field activities that vary from the written SAP. Ms. Sexton will also review the toxicity testing laboratory data to ensure that the data are valid and that the correct testing procedures were used. Mr. McAteer will review the laboratory analytical and QA/QC data to ensure that data are valid and procedures meet the required analytical quality control limits. Upon completion of the analytical and toxicity testing, the results will be incorporated into a QA/QC report.

3.5 FINAL DATA REPORT

Dr. Lawrence McCrone will be responsible for preparing the final sediment characterization report describing station locations and depths; sampling, handling, and analytical methods; QA/QC procedures; and data results.

4. SAMPLE COLLECTION AND HANDLING PROCEDURES

4.1 DEFINITIONS

The following definitions apply to this sampling program:

- **Dredging Prism**—The entire volume of sediments to be dredged, including side slopes, to a design depth of −17 ft MLLW.
- **Sediment Bore**—The entire cumulative length of sediment core extracted by the coring device, extending from the sediment/water interface down to the total penetration depth of the core.
- **Core Section**—The portion of the sediment bore between the sediment/water interface and the design dredging depth (−17 ft MLLW).
- **Dredged Material Management Unit**—The volume of dredged material for which a separate decision can be made on its suitability for unconfined, open-water disposal. DMMUs are typically characterized by chemical and biological testing of a single sample, composited from one or more core sections within the DMMU.
- **Surface Sediments**—Under PSDDA, surface sediments are generally those collected within 4 ft of the sediment/water interface. However, for this project, surface sediments are defined as those collected above the design dredging depth (−17 ft MLLW), represented by core sections of 3.5–5.3 ft in length.
- **Subsurface sediments**—Sediments collected from just beneath the surface sediments. Within the spatial area encompassed by each DMMU, one composite subsurface sediment sample will be collected and archived in the event that a determination is later needed of the sediment stratum likely to be exposed by the proposed dredging project.

4.2 NUMBER OF SAMPLES AND ANALYSES REQUIRED

PSDDA ranks the lower Duwamish River, including the vicinity of Slip No. 4, as an area of high concern for sediment contamination. For full sediment characterization in a high-concern area, PSDDA requires the analysis of one sediment sample composited over the uppermost 4 ft of the sediments for each 4,000 yd^3. Within the area proposed for dredging, nearly all of the existing bottom surface lies within 4 ft or less of the

design dredging depth of −17 ft MLLW. The only exceptions are a relatively narrow band of thicker sediments along the eastern border of the area to be dredged and two areas of shoaling near the middle of the inner half of the area to be dredged (see Figure 3). Because the bulk of the sediments proposed for dredging lies within the deeper portion of the slip (i.e., the thicker sediments in the aforementioned narrow band and in the shoaling areas represent a relatively small fraction of the total sediments proposed for dredging), it is proposed that all samples collected for analysis will be from depths above −17 ft MLLW and still be considered "surface sediments." Given a projected total dredged material volume of 13,000 yd^3, this total volume was separated into four approximately equal DMMUs of 3,250 yd^3 each (see Figure 5). Hence, four composite sediment samples are proposed, one for each DMMU.

4.3 CONCEPTUAL DREDGING PLAN AND SAMPLING AND COMPOSITING SCHEME

The proposed sampling and analysis scheme was developed considering site-specific project and environmental factors. One important goal of this sediment characterization is to ensure that individual DMMUs can be feasibly dredged independently from one another. If an individual DMMU is found to have sediments unsuitable for unconfined, open-water disposal, then those sediments can be disposed of at an alternate approved upland or nearshore site. The sampling program for the Slip No. 4 dredging project was developed as follows:

- **Prepare conceptual dredging plan**—Criteria for a dredging plan were established for this site based on the depth and physical characteristics of the sediments, the dredge layout plan including side slopes, appropriate dredging methods and equipment, and conventional construction practices at similar dredging projects in Puget Sound.
- **Prepare sampling and compositing scheme**—PSDDA guidance documents provide the basic criteria for selecting sampling locations and compositing sediment samples for analysis relative to the sediment volumes to be characterized. The approach is to delineate sediment sampling grid units as basic building blocks for identifying DMMUs capable of being dredged independently.
- **Integrate the dredging plan with the sampling and compositing scheme**—The operational aspects of dredging were related to the sample compositing scheme to ensure that individual DMMUs can be feasibly dredged independently from adjacent DMMUs.

The conceptual dredging plan included the following criteria:

- Dredging will be accomplished using a clamshell dredge.
- Throughout most of the area proposed for dredging, the design dredging depth can be achieved with a single lift of 4 ft or less.
- Disposal will be by a bottom-dump barge.

The sampling and compositing scheme was developed using the following criteria:

- Although a single sediment core section would collect sufficient sediment for all of the required physical, chemical, and biological analyses, two core sections will be collected from each DMMU and composited to give a better representation of bulk sediment characteristics within each DMMU.
- Each of the four DMMUs (see Figure 5) were defined as representing surface sediments only; there will be no subsurface DMMUs.
- Within each DMMU, the sediment cores will be collected from two stations oriented along the centerline of the DMMU in the longer dimension, and the two stations will be spaced so that each represents approximately equal areas and volumes of the DMMU.
- At each station, a sample of the subsurface sediments (i.e., from the design dredging depth of −17 ft MLLW to −18 ft MLLW) will be collected from the same sediment bore as the surface sediments and archived.

The spatial extent of the four DMMUs was defined by dividing the area proposed for dredging into four subareas, such that each represented approximately equal volumes of sediments (see Figure 5). The volumes were calculated from the difference between the bottom surface as determined from the bathymetric survey and the design dredging depth of −17 ft MLLW. Although the total volume of sediments to be dredged between these two horizons was initially estimated to be 12,080 yd^3, or just slightly greater than could be subdivided into three DMMUs (i.e., with a PSDDA maximum of 4,000 yd^3 per DMMU), allowance was made for additional material from the side slopes, as well as any minor sedimentation that may have occurred since the time of the bathymetric survey. Assuming a total volume of dredged sediments of approximately 13,000 yd^3, this equates to four DMMUs of approximately 3,250 yd^3 each, well below the PSDDA maximum of 4,000 yd^3 per DMMU.

The eight proposed sediment core sampling locations are numbered sequentially in Figure 6 and Table 2. Table 2 provides the estimated existing depths, the estimated total lengths of the sediment bores to be collected, and the core sections and designations for each of the eight stations. Table 3 describes which samples are to be composited and analyzed and which samples are to be archived for possible future analysis.

In addition to the sediment samples collected from Slip No. 4, a reference sediment sample will be collected (for use in the sediment toxicity testing) from one station in Carr Inlet (an identified reference area for Puget Sound sediment investigations [PTI 1991]).

The numbers and types of sediment samples to be collected are summarized below:

- **Slip No. 4 surface sediment samples**—A composite sediment sample (comprising two surface sediment core sections) will be collected from each of the DMMUs within Slip No. 4. The following tests and analyses will be performed on these composite sediment samples.

  - **Physical/chemical analyses**—Subsamples from each of the four site sediment samples will be analyzed for selected semivolatile organic compounds (i.e., selected acid/base/neutral compounds), selected volatile organic compounds, selected organochlorine pesticides, total PCBs, selected metals, TOC, grain-size distribution, total volatile solids [TVS], percent solids, total sulfides, and ammonia (see Appendix B).

  - **Biological Analyses**—Subsamples from each of four composite sediment samples will be analyzed for toxicity using the amphipod mortality test, sediment larval mortality and abnormality test, and juvenile polychaete (*Neanthes*) 20-day growth test. No field duplicate is required for toxicity testing because five laboratory replicate analyses of each toxicity test will be performed for each sample.

- **Reference area sediment sample**—One composite sediment sample will be collected from the Carr Inlet reference area. The reference sample will be collected in an area where sediment is unlikely to be affected by a direct pollution source and where sediment physical characteristics (e.g., grain size) are similar to those in Slip No. 4. The location chosen for collection of the reference sediment will be determined in the field based on a preliminary determination of grain size. Subsamples from this sample will be analyzed for total solids, TVS, TOC, ammonia, total sulfides, and grain-size distribution. Subsamples from the composite sediment sample will be analyzed for toxicity using the amphipod mortality test, sediment larval mortality and abnormality test, and juvenile polychaete (*Neanthes*) 20-day growth test.

- **Archived subsurface sediment samples**—Subsurface sediment samples collected from just below the design dredging depth (i.e., from −17 to −18 ft MLLW) at all eight stations in Slip No. 4 will be archived (i.e., frozen at −20°C) for possible future chemical analyses.

- **Archived surface sediment samples**—Subsamples from each of the four composite surface sediment samples from Slip No. 4 will also be archived (i.e., frozen at −20°C) for possible future chemical analyses.

4.4 FIELD SAMPLING SCHEDULE

Sampling is anticipated to be conducted in July 1995, pending availability of subcontractors and the schedule of barges using the 8th Avenue Terminal facility. In the interim, equipment and personnel will be mobilized. Sampling is estimated to require 1 working day at the Slip No. 4 site and 1 working day at the reference area (i.e., Carr Inlet). The sequence of sample collection will be arranged to maximize collection efficiency and will be determined in the field based on field conditions.

4.5 SAMPLING VESSEL OPERATION AND NAVIGATION

4.5.1 Sampling Vessels and Crews

The sampling vessel to be used for sampling in Slip No. 4 will be the R/V *Retriever*, to be provided by Marine Sampling Systems, Inc. The vessel to be used for reference area sampling will be the R/V *Kittiwake*, to be provided by Bio-Marine Enterprises. Both Marine Sampling Systems and Bio-Marine Enterprises have conducted numerous sediment sampling cruises in Puget Sound and are thoroughly familiar with the gear to be used and vessel handling procedures necessary to ensure safe and accurate deployment and retrieval.

For collection of the sediment core samples from Slip No. 4, the sampling team will consist of Mr. Matt Kramer of Marine Sampling Systems, vessel operator; Mr. Bill Jaworski of Marine Sampling Systems, operator of the coring system; one Marine Sampling Systems crew member; the PTI chief scientist; and two PTI crew members. For collection of the Carr Inlet reference area sediments, the sampling team will consist of Mr. Charlie Eaton of Bio-Marine Enterprises (the vessel operator), the PTI chief scientist, and one PTI crew member.

4.5.2 Navigation and Positioning

For collection of the sediment core samples from Slip No. 4 and from the Carr Inlet reference area, station positioning will be accomplished by using a differential global positioning system accurate to within ±3 m. Water depth will also be measured with the vessel's fathometer at the time of sampling and recorded. Elevations will be referenced to local MLLW and corrected using a tide gage installed in Slip No. 4. Horizontal coordinates will be referenced to the Washington Coordinate System and also converted to latitude and longitude to the nearest 0.1 second. These systems are

expected to allow highly accurate station positioning, such that individual DMMUs can be characterized independently of one another.

4.6 SAMPLE IDENTIFIERS

Sample identifiers will be established before field sampling begins and assigned to each sample as it is collected. Sample identifiers consist of codes designed to fulfill three purposes: 1) to identify related samples (i.e., replicates) to ensure proper data analysis and interpretation; 2) to obscure the relationships between samples so that laboratory analysis will be unbiased by presumptive similarities between samples; and 3) to track individual sample containers to ensure that the laboratory receives all of the material associated with a single sample. To accomplish these purposes, each container has a sample number and a sample tag number. These codes and their uses are described below:

- **Sample Number**—The sample number is an arbitrary number assigned to each sediment sample collected. To prevent laboratory personnel from associating related samples, the sample number appears on the sample containers, the chain-of-custody forms, and the sample analysis request forms.

- **Sample Tag Number**—A different sample tag number is attached to each sample container. If the amount of material (i.e., everything associated with a single sample number) is too large for a single container, each container will have the same sample number and a different sample tag. A sample will also be split between containers if a different preservation technique is used for each container (i.e., because different analyses will be conducted). The sample tag number will appear on the chain-of-custody forms and sample analysis request forms. Tag numbers are only used by laboratories to confirm that they have received all of the containers that were filled and shipped. Data are reported by sample number.

Sample numbers will be assigned sequentially in the field; sample tags will be preprinted with tag numbers.

4.7 SAMPLING PROCEDURES

Sediment samples will be collected at the Slip No. 4 site with an impact core sampler and at the reference area with a van Veen grab sampler, in accordance with standard methods used by PSEP (1986b; 1989a,b). Sample collection and handling methods (including criteria for judging the acceptability of samples) are described in greater detail in the following sections. Surface sediment samples will be collected from the upper level of the sediment bore (generally the 3.5- to 5.3-ft depth interval; i.e., that portion of the sediment bore lying above the design dredging depth of −17 ft MLLW) and from the upper 0–10 cm of the reference area grab sample. In addition, a sample of the

subsurface sediments (−17 to −18 ft MLLW) will be collected and archived for possible future chemical analyses.

4.7.1 Sample Collection

The coring system to be used for the collection of sediment cores in Si... impact-driven coring system (IDCS) supplied by Marine Sampling Systems. ... is a hydraulically operated sediment sampling system that features a uniquely de... hammer to drive an aluminum core tube assembly into the sediment incrementally in a... impulsive manner with a very high instantaneous velocity. The high peak forces and high instantaneous velocities generated by the impact allow penetration of plastic sediments in which vibratory systems are ineffective. The IDCS has successfully operated in materials such as thick layers of wood chips, buried logs, very stiff dewatered clays, angular and marine sand, peat, and gravel.

The impact-generating hammer is mounted on a lightweight guide/support assembly. An integral, hydraulically operated core extraction winch is mounted in the base of the guide/support assembly and generates up to 15,000 lb of pull-out force after the core tube assembly has been driven to the desired depth. The integral core extraction winch allows the core tube to be extracted, without bending, prior to lifting the coring system off the bottom with the vessel-mounted winch. Because the vessel winch is not used while the core tube assembly is embedded in the sediments, the vessel does not need to be anchored nor does its position need to be accurately maintained during the coring operation.

Another unique feature of the IDCS is the penetration- or core-acquired monitoring system. During the coring operation, the penetration of the core tube is continuously monitored and recorded. At any desired interval, the length of the core acquired up to that point can also be monitored. Thus, correlation of cored material to depth of burial is possible. The percentage of material recovered from any penetration interval is also directly available from the penetrometer- or core-acquired data.

The aluminum core tubes used to collect the sediment cores will be washed and scrubbed with detergent and then rinsed with distilled water prior to use. Each core tube is used only once, so there is no potential for cross-contamination among cores. Each sampling station will be located by using the differential global positioning unit. The impact corer will be deployed within ±3 m of the intended station location. At this time, the vessel will be anchored to the corer with the hydraulic hose and rope. The core assembly will be lowered until it rests upright on the sediment surface. The core tube will be driven into the sediment until a sediment core of sufficient length is obtained or until refusal. The actual depth of sediment collected inside the core tube will be measured by using a penetrometer. A penetrometer is essentially a depth sounder located inside the core tube. The core depth information will be recorded on core data sheets during the coring activity. Because the IDCS is impact driven, the penetration- or core-acquired data can be recorded as a function of both time and blow counts.

The penetrometer readings will be continuously monitored during the coring operation. At desired points during the coring operation, usually at 2 ft intervals, the hammer will be stopped and the core-acquired reading will be taken and recorded with the penetration at that time. When the maximum desired penetration has been achieved, the hammer will be stopped and a final core-acquired reading will be taken and recorded. The core tube assembly will then be extracted by the guide-assembly-mounted extraction winch. During the extraction process, the core pull-out loss (normally 0–7 cm because of closure of the core catcher) will be recorded. A computer onboard the vessel will then be used to calculate the relationship between length along the core and the depth of penetration.

Total depth of penetration and core recovery will depend on subsurface conditions. Minimum acceptable depth of sample recovery will be 5–7 ft, depending on the station (Table 2). If a shorter core is recovered, collection of an alternate core of greater length will be attempted as close as possible to the original core location.

After core samples are retrieved, the core tube will be cut into sections corresponding to the desired sampling intervals in the sediment column (Table 2) at the locations determined by the penetration calculation. Cutting the core tube sections will be accomplished by using a pipe cutter (oil will not be used on the cutting equipment). Care will be taken not to cut into the sediment material. Each end of the core tube sections will be capped with aluminum foil and duct tape. The core tube sections will be marked with the following:

- station identification;
- depth interval;
- bottom and top;
- time sampled; and
- initials of samplers.

The core samples will then be placed horizontally in a cooler with ice. Prior to deployment at a new location, any sediment adhering to the IDCS assembly will be washed off with a seawater hose.

The PTI chief scientist on the sampling vessel will be responsible for station positioning and documenting sampling activities. All information concerning core sampling will be entered in a field notebook.

The sediment core sections will be transferred to shore for processing. Onshore, the sediment core samples will be extruded into a V-shaped trough lined with aluminum foil. Subsamples for the analysis of volatile organic compounds and total sulfides will be collected immediately thereafter. One 60-mL container will be completely filled with sediment for the analysis of volatile organic compounds. No headspace will be allowed to remain in the container. The containers, screw caps, and cap septa (silicone vapor barriers) will be washed with detergent, rinsed once with tap water, rinsed at least twice

with distilled water, and dried at >105°C. A solvent rinse will not be used because it may interfere with the analysis. To avoid leaving headspace in the containers, sample containers can be filled in one of two ways. If there is adequate water in the sediment, the vial will be filled to overflowing so that a convex meniscus forms at the top. Once sealed, the container will be inverted to verify the seal by demonstrating the absence of air bubbles. If there is little or no water in the sediment, jars will be filled as tightly as possible, eliminating obvious air pockets. With the cap liner Teflon®-side down, the cap will be carefully placed on the opening of the vial, displacing any excess material.

For the sample intended for the analysis of total sulfides, 8 mL of 2N zinc acetate will be placed in a 250-mL sampling jar. The total sulfides sample (approximately 50 g) will be placed in the jar, covered, and shaken vigorously to completely expose the sediment to the zinc acetate.

If, following extrusion, the sediment core retains its form (i.e., the sediment does not collapse into an amorphous mass of sediments), the following observations regarding the sediment core will be noted and recorded:

- physical sediment description (e.g., color, predominant grain size);
- odor (e.g., hydrogen sulfide, petroleum);
- visual stratification (if any);
- presence of vegetation;
- presence of debris;
- biological characteristics (e.g., detritus, shells, tubes, bioturbation, live or dead organisms);
- presence of oil sheen or droplets; and
- any other distinguishing characteristics or features.

After recording such observations, the sediment core sample will be transferred to a pre-cleaned bucket. The bucket will be covered with aluminum foil and kept in a cooler until the other sediment core sample to be composited with it has been similarly processed. The second sediment core sample will be added to the first, and the two samples will be mixed to visible uniformity. Subsamples will then be transferred into the appropriate containers for the individual analyses (Table 4) and then processed and shipped according to sample handling and custody procedures. The compositing bucket and all sampling equipment will then be decontaminated prior to processing the next sediment core sample. Decontamination will consist of scrubbing with Alconox®, rinsing with deionized water, rinsing with acetone and then hexane, air-drying, and rinsing again with deionized water.

Prior to sampling at the reference area station, the van Veen grab sampler and all other sampling equipment will be scrubbed with Alconox®, rinsed with site seawater, solvent-rinsed with acetone and then hexane, air-dried, and rinsed with site seawater. The

acetone and hexane rinsates will be collected in a container, and the small volume collected will be allowed to evaporate.

At the reference area station, sediments will be collected using the van Veen grab sampler. Material collected in the grab sampler will be evaluated for acceptability using the following criteria:

- The grab sampler is not overfilled.
- Overlying water is present.
- The overlying water is not excessively turbid.
- The sediment surface is relatively undisturbed.
- An adequate penetration depth is attained (i.e., 0–10 cm).

The PTI chief scientist will evaluate all samples collected. If a sample fails to meet any of the above criteria, it will be rejected and discarded away from the station. After a sediment sample is judged to be acceptable, the overlying water will be siphoned off and the specified amount of surface sediment (0–10 cm) will be collected in accordance with PSEP guidelines. Stainless-steel spatulas and spoons will be used to collect the sediment.

The surface sediment collected with the van Veen grab sampler at the reference station will be composited in a stainless-steel bowl and covered with aluminum foil until a sufficient volume of sediment (a minimum of 7 L) has been collected. Sediment in the bowl will then be mixed using a large stainless-steel spoon to achieve a uniform texture and color before subsamples are taken and transferred to precleaned glass containers with Teflon®-lined lids (Table 4).

4.7.2 *Field Determination of Grain Size*

To minimize any grain-size interferences that may occur during sediment toxicity testing, it is important that the grain size of the reference area and onsite sediments are similar. The selection of the reference area station will be confirmed based on field determinations of the approximate grain size of subsamples of the Slip No. 4 sediment samples and a subsample of the sediment collected at the reference area.

Grain size will be determined in the field using the following method developed by PTI and the Corps, Seattle District. A 50-mL subsample will be removed from the sediment sample and then sieved through a 63-μm sieve. The retained material will be transferred to a graduated cylinder. The volume of retained material will provide an estimate of the sand and gravel fraction of the sediment.

4.7.3 Sample Handling

All sample containers will be provided by the laboratory and prepared in accordance with PSEP guidelines (PSEP 1986a) prior to field operations. Sample containers will be kept closed and in a cooler until use. As they are collected, samples will be fully labeled, recorded in the field notebook along with other pertinent collection data, and returned to coolers as soon as possible. Immediately after they are filled, all sample containers will be placed on ice in a cooler at 4°C. For those subsamples that will be frozen (i.e., archive samples), sufficient headspace will be left in each jar to accommodate expansion during freezing.

Sediment samples for all chemical analyses will be shipped on ice (4°C) to the testing laboratories and will be stored at 4°C until analysis and final disposition of the samples. All field samples, except archived chemical samples, will be analyzed as soon as possible after receipt at the laboratory. Maximum sample holding times are stipulated in Table 4. The holding times for archived chemical samples will be extended by freezing these samples at the laboratory. Each frozen sample will be stored at an angle to minimize breakage and will be placed in an outer plastic bag to avoid cross contamination should breakage occur. Sediment samples for possible future chemical analyses will be frozen within 24 hours of receipt by the laboratory. The archived samples for possible future chemical analyses will be held at the laboratory pending a decision to begin analyses within the specified holding time for frozen samples.

Chain-of-custody and sample analysis request forms will be completed and signed at the end of the day and shipped with the samples to the analytical laboratories. Samples will be shipped or sent by courier to the participating laboratories at the end of the sampling event. Samples for analysis of semivolatile organic compounds, volatile organic compounds, pesticides/PCBs, and TOC will be delivered to Analytical Resources, Inc. in Seattle, Washington. Samples for metals, TVS, total sulfides, ammonia, grain-size analysis, and archiving will be sent to Columbia Analytical Services, Inc. in Kelso, Washington. Samples for sediment toxicity testing will be sent to Northwestern Aquatic Sciences in Newport, Oregon.

Samples shipped or sent by courier to the laboratories will be packed in bubble-wrap plastic to prevent breakage, and chain-of-custody seals will be placed across the cooler lids. Chain-of-custody forms will be enclosed in the coolers with the samples and will be signed at the laboratory upon receipt. A copy of the signed form will be returned to PTI.

4.8 DOCUMENTATION

The integrity of each sample from the time of collection to the point of data reporting must be maintained throughout the study. Proper recordkeeping and chain-of-custody procedures will be implemented to allow samples to be traced from collection to final

disposition. Various logs and forms are required to adequately identify and catalog station and sample information, including the following:

- **Station/sample log**—Each gear deployment event will be recorded on a station/sample log sheet. One or more station/sample log sheets will be completed for each station sampled. The station name, date, gear, cast number, depth, and location coordinates will be recorded on each log sheet. Penetration depth, sediment type, sediment color, sediment odor, visual stratifications and lenses, vegetation, debris, biological activity (e.g., detritus, shells, tubes, bioturbation, live or dead organisms), presence of oil sheen, and any other distinguishing characteristics or features will also be recorded for sediment samples. The sample type, sample identifier, sample number, and sample tag number will also be recorded on the station/sample log sheet.

- **Chain-of-custody form**—Each sample container will be recorded on a chain-of-custody form. Both the sample tag number and the sample number will be shown. The chain-of-custody form will also identify the sample collection date and time, the type of sample, the project, and the chief scientist. The chain-of-custody form will be sent to each laboratory analyzing a fraction of a sample. Chain-of-custody forms will be completed in triplicate, with one copy retained by the chief scientist.

- **Sample analysis request form**—Each set of samples sent to a laboratory will be accompanied by a sample analysis request form. The sample analysis request form will identify samples by sample number and sample tag. For each sample tag, the sample analysis request form will identify the preservative or other sample pretreatment applied and the analyses to be conducted by referencing a list of specific analytes or the statement of work for the laboratory. One copy of this form will be retained by the chief scientist, and the original form will accompany the shipment.

- **Sample label and chain-of-custody seal**—A sample label will be completed for each sample. Sample containers will be labeled prior to the time of sampling with the following information: sample number, site name, sampling date and time, sampling personnel, preservative (if appropriate), and tag number. A chain-of-custody seal will be placed across the lid of the cooler prior to shipping.

At the time of sampling, the sample number and analysis code for each sediment subsample will be recorded in the field logbook. At the end of each day, and prior to shipping or storing, chain-of-custody entries will be made for all samples. Finally, information on the labels will be checked against field logbook entries, and samples will be recounted.

Station and sample logs will be completed at the time the observations are made. Chain-of-custody forms and sample analysis request forms will be completed and signed before the end of each sampling day and before the samples are removed from the vessel or pass

from the control of the PTI chief scientist. Chain-of-custody forms will be signed at each additional point of transfer of samples between the field and the laboratory and within the laboratory. Copies of all forms will be retained by PTI and included as appendices in the resulting data report.

Standard logs and forms will be used by PTI to record information at each sampling location. A bound field notebook will also be completed for sampling within Slip No. 4 and in the Carr Inlet reference area. Any changes in the sampling procedures described in this SAP will be documented in the field notebook.

4.9 SAMPLING SAFETY

Safety hazards are associated with the equipment and supplies that will be used, as well as with the general rigors of work on the water. A health and safety checklist is routinely completed by PTI and carried onboard the sampling vessels for all sediment sampling events to identify potential hazards, institute procedures for minimizing those hazards, prepare the proper responses in case of accident and injury, and make this information known to all shipboard personnel. Prior to sampling, a health and safety briefing will be held onboard the vessel.

To ensure safe and efficient shipboard operations, the PTI chief scientist will be designated safety officer responsible for all shipboard operations, including evaluating hazardous conditions, ensuring compliance with safety precautions, and suspending shipboard operations if necessary. A halt to or suspension of operations can also be dictated by the vessel operator.

4.9.1 Hazards

Hazards encountered during sampling are generally classified as either chemical or physical. Chemical hazards are primarily associated with the materials used to clean sampling gear. Physical hazards are associated with the gear and conditions of work on the water.

4.9.1.1 Chemical Hazards

Stations to be sampled during the survey are not expected to contain concentrations of chemicals (including natural sulfides) that pose a hazard to human health. During field operations, if excessive odor, nonaqueous liquids, or organic enrichment is observed, the sampling plan will be reassessed. Precautionary steps may include artificially ventilating the rear deck, instituting suitable protective measures for the crew, or relocating or eliminating the sampling station.

Acetone and hexane will be used to clean the sampling equipment. Both are clear, colorless, volatile solvents with strong odors. Acetone and hexane will be used only on the open deck and personnel must wear protective gloves when handling these liquids.

4.9.1.2 Physical Hazards

Gear deployment and retrieval present hazards because of the weight of the sampling gear, its suspension above the deck, and the risk of entanglement or accidental or premature release or closure. While gear deployment hazards are expected to be minimal, physical hazards associated with the van Veen sampler do exist.

During retrieval of the van Veen grab sampler, at least one crew member will watch for the sampling gear to appear and alert the winch operator. Failure to observe the sampling gear and stop the winch can break the cable, lose the sampling gear, and possibly injure personnel with falling gear or the end of the broken cable. The winch drum, the blocks, and the area between the sampling gear and the rail, deck, or other large equipment present significant pinching and crushing hazards. Personnel will be instructed to keep their hands, feet, and clothing clear of these points and to wear steel-toed boots and hardhats at all times while on deck.

Lines, hoses, hatch covers, and mud on the deck present tripping, slipping, and falling hazards. Every crew member will be instructed to keep the working surface of the deck clear and clean by coiling hoses and lines and rinsing accumulations of mud from the deck. In addition, all crew members will remain aware of hatch cover positions and other gear at all times.

A drowning hazard exists for shipboard personnel working on the water primarily from tripping (discussed above) or excessively rough weather. Flotation vests will be worn by all personnel on deck. The sampling vessels are also equipped with throwable life rings, and each crew member will be briefed on the use and storage location of these rings.

Fatigue presents a hazard when working on the water and can be compounded by the motion of the vessel, exposure, or hypothermia. Personnel will monitor their own condition and capabilities and are responsible for taking appropriate measures to relieve fatigue or exposure. The PTI chief scientist may also direct any member of the crew to cease working.

4.9.2 Safe Work Practices

Precautions for handling chemicals include wearing gloves, restricting use to the deck, storing and dispensing them from narrow-mouth bottles or squirt bottles, and exercising care in use. Solvent rinsate from sampling gear will be collected in a container so excess

solvent is not spilled on the deck. The sea condition and presence of wakes or other disturbances will be noted to avoid spillage.

All crew members will wear hardhats when working on the deck. Work gloves will be available but not required (impermeable gloves are required when using acetone or hexane). Flotation vests will be worn by all personnel on deck.

During gear deployment and retrieval, personnel should pay close attention to the position of the gear, the motion of the boat, obstructions on the deck that could impede their mobility, and actual or potential fouling of the gear. Hands and feet must never be placed underneath sampling gear.

Weather conditions will be monitored by the PTI chief scientist and vessel operator. The vessel is supplied with emergency flotation equipment and fire extinguishers. Food and shelter (the vessel's cabin) will be provided for the sampling crew. Each crew member will be required to bring clothing appropriate for the weather to minimize the hazards of exposure and hypothermia.

4.9.3 *Emergency Planning*

If an emergency or accident occurs during sampling, the PTI chief scientist and vessel operator will determine the appropriate response. This includes assessing the severity of the incident and, if appropriate, contacting emergency assistance. The vessel operator is responsible for moving the boat into position to receive emergency aid, if necessary. A basic first-aid kit will be kept onboard to treat minor cuts or scrapes. All PTI field personnel have received first aid and CPR training. All accidents must be reported to the PTI chief scientist and will be recorded in the cruise log. Contact information for local emergency services, hospitals, and ambulance services will be onboard the boat in a location known to and accessible to all personnel. Emergency contact information is provided in the health and safety checklist, which will be carried onboard both sampling vessels.

5. LABORATORY PHYSICAL AND CHEMICAL SEDIMENT ANALYSES

5.1 LABORATORY ANALYSES PROTOCOLS

Laboratory testing procedures will be conducted in accordance with the PSDDA Evaluation Procedures Technical Appendix (PSDDA 1988), the PSDDA Phase II Management Plan Report (PSDDA 1989), and the PSEP Protocols (PSEP 1991). All parameters listed in Appendix B will be analyzed. Several details of these procedures are discussed below.

5.1.1 Chain-of-Custody

A chain-of-custody record for each set of samples will be maintained throughout all sampling activities and will accompany samples and shipment to the laboratory. Information tracked by the chain-of-custody records in the laboratory include sample identification number, date and time of sample receipt, required analyses, location and conditions of storage, date and time of removal from and return to storage, signature of person removing and returning the sample, reason for removing from storage, and final disposition of the sample.

5.1.2 Limits of Detection

The composited surface samples identified in Section 4.2 and Table 3 will be analyzed for all the parameters listed in Appendix B and for grain-size distribution. The preparation procedures; test methods; method detection limits to be achieved by the analytical laboratory; and PSDDA SLs, bioaccumulation trigger (BT) values, and MLs are also identified in Appendix B. Detection limits of all chemicals of concern must be below PSDDA screening levels. Failure to achieve this may result in a requirement to reanalyze. The analytical laboratories will be specifically cautioned by the PTI chemist to make certain that they comply with the PSDDA detection limit requirements. All reasonable means, including additional cleanup steps and method modifications, will be used to bring all limits-of-detection below PSDDA SLs. In addition, subsamples of each composited sediment sample will be archived and preserved at −20°C for additional analyses, if necessary. In all cases, to avoid potential problems and leave open the option for retesting, sediments or extracts will be kept under proper storage conditions until the chemistry data are deemed acceptable by the PSDDA agencies.

5.1.3 Sediment Conventionals

All conventional parameters listed in Appendix B will be analyzed. Particle grain-size distribution for each composite sample will be determined in accordance with ASTM D 422 (modified). Wet sieve analysis will be used for the sieve sizes U.S. No. 4, 10, 20, 40, 60, 140, 200, and 230. Hydrogen peroxide will not be used in preparations for grain-size analysis because it breaks down organic aggregates and its use may provide an overestimation of the percent fines found in undisturbed sediment, resulting in incorrect grain-size matches when reference sediments are collected. Hydrometer analysis will be used for particle sizes finer than the 230 mesh. Water content will be determined using ASTM D 2216. Sediment classification designation will be made in accordance with U.S. Soil Classification System, ASTM D 2487.

5.1.4 Holding Times

All samples for physical and chemical analyses will be stored in accordance with proper procedures and analyzed within the maximum holding times for each analysis (Table 4).

5.1.5 Quality Assurance and Quality Control

The chemistry QA/QC requirements listed in Table 5 will be followed.

5.2 LABORATORY WRITTEN REPORT

A written report will be prepared by each analytical laboratory documenting all the activities associated with sample analyses. At a minimum, the following will be included in the reports:

- results of the laboratory analyses and QA/QC results;
- all protocols used during analyses;
- chain-of-custody procedures, including explanation of any deviation from those identified herein;
- any protocol deviations from the approved SAP;
- location and availability of data; and
- QA2 data required by the Washington Department of Ecology for the SEDQUAL database (see Appendix C).

As appropriate, this SAP may be referenced in describing protocols.

6. BIOLOGICAL ANALYSIS METHOD

6.1 CONCURRENT CHEMICAL AND BIOLOGICAL ANALYSES

Based on results of the pilot sediment characterization study (Table 1), it was considered highly likely that one or more chemicals in the bulk sediment samples will exceed PSDDA SLs. Therefore, concurrent chemical analyses and toxicity testing are proposed (i.e., a tiered testing approach is not proposed). Sediment subsamples will be sent simultaneously to the chemical and biological laboratories, and chemical analyses and biological testing will be initiated within the prescribed maximum holding times (Table 4).

In the event that one or more BT values (see Appendix B) are exceeded in the sediments to be analyzed, additional bioaccumulation tests would have to be performed. Approximately 16 L of additional sediment would be required for bioaccumulation testing for each DMMU. Because of the substantially higher cost of collecting this additional volume of sediments, sufficient sediments will not be collected in the initial sampling effort. If a BT value is exceeded and Crowley decides to pursue bioaccumulation testing, additional sediment will be collected in a second sampling effort, focusing only on the DMMU(s) where there were exceedances of the BT values(s). Crowley compared the costs involved with collecting large volumes of additional sediments for each DMMU immediately with the costs of a resampling effort, and decided on the latter strategy.

6.2 IDENTIFICATION OF REFERENCE AREA SEDIMENT

PSDDA guidelines require that sediment toxicity tests be run with an appropriate PSDDA-approved reference sediment to factor out sediment grain-size effects on the test organisms. To evaluate the approximate grain-size distribution of the Slip No. 4 sediments, the field screening procedure (see Section 4.7.2) will be conducted on each of the composite sediment samples from the four DMMUs. The Carr Inlet reference station will be selected so as to match, as closely as possible, the estimated average percent sand and gravel in these four composite sediment samples. The same field screening procedure will be used on the Carr Inlet reference samples to confirm the appropriateness of the match.

6.3 GENERAL BIOLOGICAL TESTING PROCEDURES

The acute toxicity and chronic sublethal sediment toxicity test prescribed by PSDDA (amphipod, sediment larval, *Neanthes* growth) will be conducted on subsamples from

each of the four composite sediment samples collected from Slip No. 4. All biological testing will be in compliance with *Recommended Protocols for Conducting Laboratory Bioassays on Puget Sound Sediments* (PSEP 1991), appropriate modifications as specified by PSDDA (1989), public workshops, and the annual review process. General biological testing procedures and specific procedures for each sediment toxicity test are summarized in the following sections.

6.3.1 Sample Holding Requirements

All sediment samples for biological testing will be sorted at 4°C until the initiation of testing by the biological laboratory. Sediment toxicity testing will be pre-planned to include obtaining test organisms and control and reference sediments in a timely manner so that the tests can be initiated by the laboratory with 14 days of sampling. In addition, a second set of sediment subsamples from each composite sediment sample will be delivered to the biological laboratory in the event that a second round of any of the toxicity tests might need to be conducted. These sediment subsamples will have their headspaces purged with nitrogen and then stored at 4°C. This method allows these samples to be stored up to 56 days from the date of sampling in the event that a second round of toxicity testing becomes necessary. The PTI project manager and the biological laboratory representative will maintain close coordination with the Corps' Dredged Material Management Office to expedite decisions regarding the possible need for any repeated toxicity tests.

PSDDA is no longer requiring testing by permittees of sediment using the Microtox® toxicity test. PSDDA, however, still requires the collection of sediment subsamples for use in this test by the PSDDA agencies. These sediment subsamples will be collected and stored at 4°C until delivery to the Corps.

6.3.2 Negative Control Sediments

Negative control sediments are used in the amphipod and *Neanthes* toxicity tests to check laboratory performance. Negative control sediments are clean sediments in which the test organism normally lives and which are expected to produce low toxicity. Control sediments will be collected from Yaquina Bay, Oregon, by the biological laboratory.

The sediment larval test utilizes a negative seawater control rather than a control sediment. The seawater control will be collected by the biological laboratory.

The amphipod, sediment larval, and *Neanthes* tests all have performance standards for negative controls; these standards are identified in Section 6.4

allowed to equilibrate overnight, without aeration, prior to addition of test organisms. Gentle aeration will be applied during the test to ensure that dissolved oxygen concentrations do not fall below the method goal specified in the test protocols.

Pretest mortality of test organisms should not exceed 5 percent, and only healthy organisms of similar size and life history stage will be used for the toxicity tests. Test organisms will be placed into the treatment containers in a random fashion to avoid a systematic bias.

6.4 SPECIFIC TOXICITY TESTS

6.4.1 Amphipod Toxicity Test

This acute lethal test measures mortality and failure of adult amphipods to rebury in sediment after exposure for 10 days to test sediment. The test species used in the present study is intended to be *Rhepoxynius abronius*. The use of *R. abronius* will be confirmed by the results of field screening of sediment grain size and interstitial water salinity tests conducted by the laboratory. *R. abronius* will only be used if the interstitial water salinity is $\geq$25 ppt and the sediments are $\leq$60 percent fine-grained (i.e., silt and clay). If the interstitial water salinity is $\geq$25 ppt and the sediments are >60 percent fine-grained, then *Ampelisca abdita* will be used. If the interstitial water salinity is <25 ppt, then *Eohastorius estuarius* will be used. Protocols are described in detail in PSEP (1991). The control sediment has a performance standard of 10 percent mortality. The reference sediment has a performance standard of 20 percent mortality greater than control.

Adult amphipods will be collected in the field and acclimated to the test water temperature and salinity for 3–4 days prior to testing. For each toxicity test replicate, 20 amphipods will be exposed to a 2-cm layer of bedded test sediment in a 1-L chamber filled with clean seawater. Five replicate analyses will be conducted for each sample. After the 10-day exposure period, the surviving amphipods in each test chamber will be sieved from the sediment and counted. Percent mortality will be determined relative to the total of 20 individuals added to each chamber at the beginning of the test. Biological effects criteria for evaluating test results are based on mortality results.

A positive control that involves determining 96-hour LC_{50} and EC_{50} values for amphipods exposed to a reference toxicant in clean, filtered seawater without sediment (following standard toxicity test procedures and under the same general test conditions as the sediments) is also required. Such data are necessary to determine the relative sensitivity of the animals (e.g., seasonal difference in sensitivity) for each test series to ensure comparability of the data.

6.4.2 *Sediment Larval Test*

This acute sublethal test monitors the larval development of a suitable echinoderm species for 48 hours to test sediment. For this project, the sand dollar (*Dendraster excentricus*) is selected as the test organism. A slightly longer exposure period may be used if necessary to achieve adequate development of embryos in seawater controls. Exposure time will not exceed 96 hours. This test will be conducted in accordance with the protocols described in detail in PSEP (1991).

Adult echinoderms will be collected in the field and acclimated to the test water temperature and salinity for at least 2 days prior to testing. The adult will be spawned in the laboratory after appropriate conditioning. For each toxicity test replicate, between 15 and 30 echinoderm embryos/mL will be exposed to control or test sediment. Five replicate analyses will be conducted for each sample. For each toxicity test replicate, 20,000–40,000 developing embryos from a pooled sample will be added to a 1-L test chamber within 2 hours of fertilization. Each test chamber will contain 20 g of test sediment and will be filled with clean seawater (i.e., 20 g of control or test sediment/1 L of clean seawater). After the sediment is added to each chamber, the sediments will be suspended by vigorous shaking for 10 seconds and the suspended sediments will be allowed to settle for 4 hours prior to the addition of larvae. After the exposure period, the seawater in each chamber will be decanted. After homogeneous mixing, a 10-mL subsample will then be collected by pipette and fixed with a 5-percent solution of buffered formalin. Preserved samples (equal in volume to those containing 300–500 larvae in controls) will be examined. Normal and abnormal larvae will be enumerated to determine percent survival and percent abnormality. A minimum sample size of 20 living larvae in each of the five replicate test chambers for test sediment and reference area sediment and 100 larvae in each replicate chamber for the seawater control will be scored for abnormalities. Embryos that fail to transform to the four-armed pluteus stage are considered abnormal. Percent mortality will be determined separately relative to the number of larvae that survive exposure to clean seawater (i.e., negative seawater control). A combined endpoint based on percent abnormality and percent mortality will also be estimated and used for comparison with biological effects criteria.

A positive control that involves determining 48-hour LC_{50} and EC_{50} values for echinoderm larvae exposed to reference toxicants in clean, filtered, or ultraviolet-treated seawater without sediment (following standard toxicity test procedures and under the same general test conditions as the sediment tests) is also required. Such data are necessary to determine the relative sensitivity of the larvae. The seawater (negative) control has a performance standard of 30 percent combined mortality and abnormality. The reference sediment has a performance standard of 35 percent combined mortality and abnormality normalized to the seawater control.

Toxicity associated with ammonia and/or sulfides may interfere with the results for this toxicity test. Aeration will be conducted throughout the test to minimize the potential for such effects.

6.4.3 *Neanthes* Growth Test

This test measures mortality and growth in juvenile polychaetes (*Neanthes* sp.) exposed for 20 days to test sediment as described by Johns et al. (1990). This test will be conducted in accordance with the protocols and QA/QC performance standards described in PSEP (1991).

Juvenile polychaetes will be obtained from laboratory cultures, acclimated to the test water temperature and salinity, and fed prawn flakes. For each toxicity test replicate, five polychaetes of relatively uniform size (0.5–1.0 mg dry weight) will be exposed to 150 g of test sediment in a 1-L chamber filled with clean seawater. Five replicate chambers will be used for each sample. Every second day, approximately 40 mg of prawn flakes will be added to each test chamber for food. Every third day, 33 percent of the water volume in each chamber will be exchanged with fresh seawater to prevent water quality from deteriorating. Before testing, three random subsamples of polychaetes (five individuals per subsample) will be dried at 50°C for 24 hours and weighed to the nearest 0.1 mg to provide an estimate of initial biomass. After the 20-day exposure period, the survivors in each test chamber will be counted. Percent mortality will be determined relative to the total of five individuals added to each chamber at the start of the test. All survivors will be dried at 50°C for 24 hours and weighed to the nearest 0.1 mg to determine the final biomass for each replicate. The average individual growth rate (mg dry weight/individual-day) will then be determined by subtracting the initial average individual biomass from the final average individual biomass and dividing by the test duration (20 days). The percent decrease in average individual growth relative to the negative control will then be determined by subtracting the replicate-specific estimate of individual growth from the estimate of average individual growth in the control, dividing by the control growth estimate, and multiplying by 100. Biological effects criteria for evaluating test results are based on growth results.

A positive control that involves determining 96-hour LC_{50} and EC_{50} values for *Neanthes* exposed to a reference toxicant in clean, filtered seawater without sediment (following standard toxicity test procedures and under the same general test conditions as the sediment tests) is also required. Such data are necessary to determine the relative sensitivity of the animals (e.g., seasonal difference in sensitivity) for each test series to ensure comparability of the data.

The control sediment has a performance standard of 10 percent mortality. The reference sediment has a performance standard of 80 percent of the control sediment growth rate.

6.5 BIOLOGICAL LABORATORY WRITTEN REPORT

A written report will be prepared by the biological laboratory documenting all the activities associated with the sediment toxicity tests. At a minimum, the following information will be included in the report:

- Results of the laboratory toxicity tests, water quality monitoring, and QA/QC results, reported both in hard copy and in the Corps' Dredged Analysis Information System (DAIS) data format. Appendix D summarizes data required for the DAIS. Original data will be legible or typed. Illegible data may result in the need for a retest if the PSDDA agencies cannot interpret the data as a result.
- All protocols used during analyses, including explanation of any deviation from the toxicity test protocols and the approved sampling plan.
- Chain-of-custody procedures, including explanation of any deviation from the approved sampling plan.
- Location and availability of data, laboratory notebooks, and chain-of-custody forms.

6.6 TOXICITY TEST INTERPRETATION

Interpretation of toxicity test results consists of endpoint comparisons to controls and reference on an absolute percentage basis as well as statistical comparison to reference. Test interpretation will follow the guidelines established in PSDDA (1989) for the amphipod and sediment larval toxicity tests and in the minutes of the dredging year 1991 annual review meeting for the *Neanthes* toxicity test, as modified by subsequent annual PSDDA review proceedings and workshops.

6.7 NEED FOR REPEATING BIOLOGICAL TESTS

In the event that any of the toxicity tests yield anomalous results, it may be necessary to repeat one or more of the tests. Any retesting will be fully coordinated with, and approved by, the PSDDA agencies. The Corps' Dredged Material Management Office will be contacted to handle this coordination.

- Data results. In addition, the results of all field and laboratory analyses and associated quality assurance data will be submitted on diskettes using the Corps' DAIS format (see Appendix D).
- QA2 data required by the Washington Department of Ecology for data validation prior to entering the data into the SEDQUAL database. Data requirements are summarized in Appendix C.
- Sampling and analysis cost data will be submitted upon project completion on forms provided by the Corps' Dredged Material Management Office.

8. REFERENCES

Johns, D.M., T.C. Ginn, and D.T. Reish. 1990. Protocol for juvenile *Neanthes* sediment bioassay. EPA 910/9-90-011. Prepared for U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Puget Sound Estuary Program, Seattle, WA. PTI Environmental Services, Bellevue, WA.

PSDDA. 1988. PSDDA evaluation procedures technical appendix. Prepared by the Puget Sound Dredged Disposal Analysis Program. U.S. Army Corps of Engineers, Seattle District, Seattle, WA.

PSDDA. 1989. PSDDA Phase II management plan report. Chapter 5 and Appendix A. Prepared by the Puget Sound Dredged Disposal Analysis Program. U.S. Army Corps of Engineers, Seattle District, Seattle, WA.

PSEP. 1986a. General QA/QC considerations for collecting environmental samples in Puget Sound. U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Puget Sound Estuary Program, Seattle, WA.

PSEP. 1986b. Recommended protocols for measuring conventional sediment variables in Puget Sound. U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Puget Sound Estuary Program, Seattle, WA.

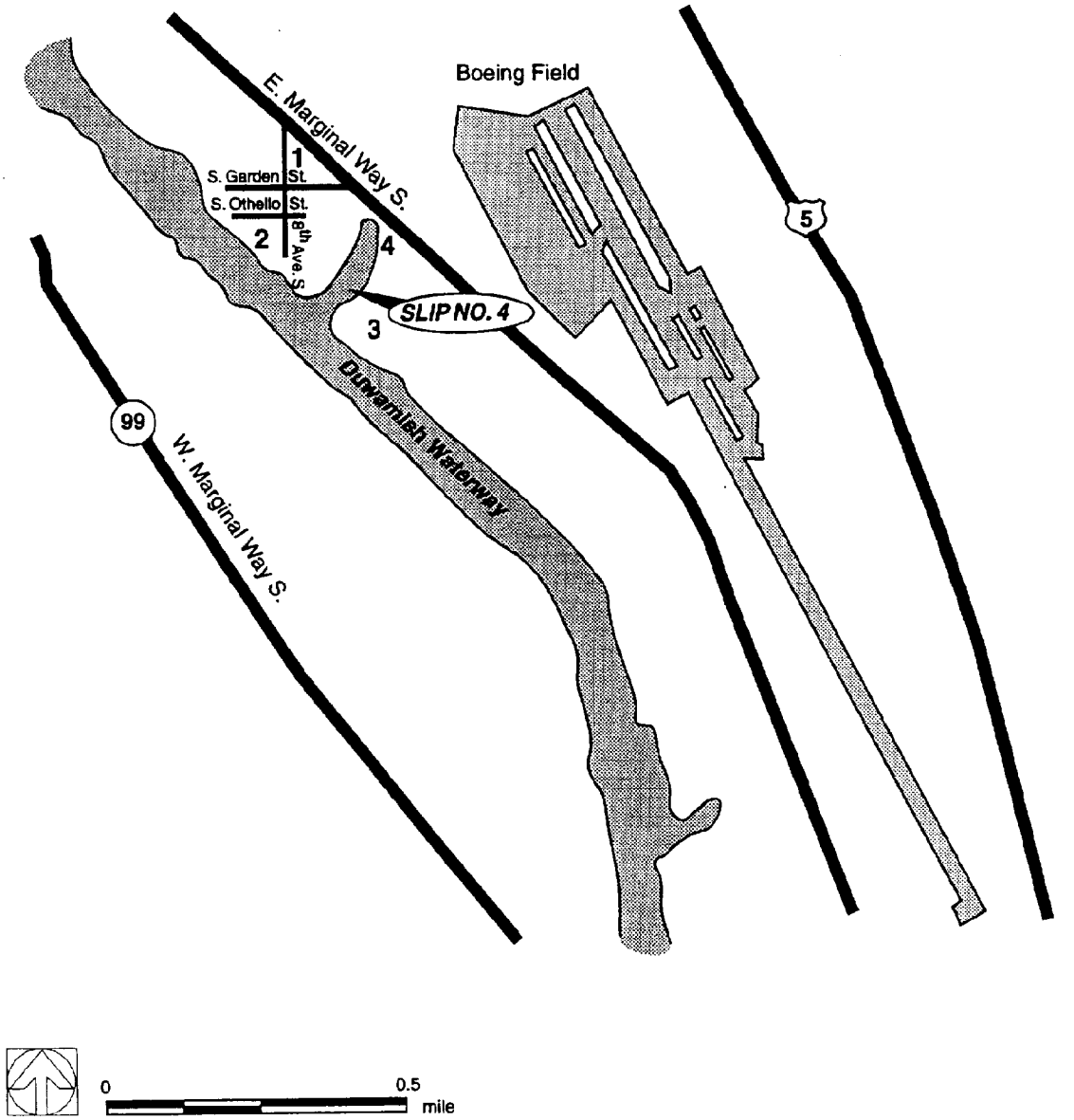
PSEP. 1989a. Recommended guidelines for measuring organic compounds in Puget Sound sediment and tissue samples. U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Puget Sound Estuary Program, Seattle, WA.

PSEP. 1989b. Recommended protocols for measuring metals in Puget Sound water, sediment and tissue samples. U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Puget Sound Estuary Program, Seattle, WA.

PSEP. 1991. Recommended protocols for conducting laboratory bioassays on Puget Sound sediments. Prepared for U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Puget Sound Estuary Program, Seattle, WA. PTI Environmental Services, Bellevue, WA.

PTI. 1995. Sediment characterization study. Crowley's Pacific Terminal facility, Seattle, Washington. Prepared for Crowley Environmental Services, Seattle, WA. PTI Environmental Services, Bellevue, WA. 14 pp.

Figures



ADJACENT PROPERTY OWNERS OR LESSEES:

1. Markey Machinery Co., Inc.
   7266 8th Ave. S.
   Seattle, WA 98108
2. Puget Sound Freight Lines
   3720 Airport Way S.
   Seattle, WA 98108
3. Boeing Aircraft Co., Inc.
   7755 E. Marginal Way S.
   Seattle, WA 98108
4. Evergreen Marine Leasing
   First Interstate Bank
   P.O. Box 160-MS-247
   Seattle, Wa 98111

Figure 1. Vicinity map.

Crowley Marine Services
8th Avenue Terminal
7400 8th Ave. S.
Seattle, WA 98108

PROPOSED DREDGING

IN: Slip No. 4, Duwamish Waterway

AT: Seattle

COUNTY OF: King STATE: WA

APPLICATION BY:
Crowley Marine Services

SHEET: DATE: 03/29/95

C483-06-02 05/12/95

KCSlip4 59499

SEA425798

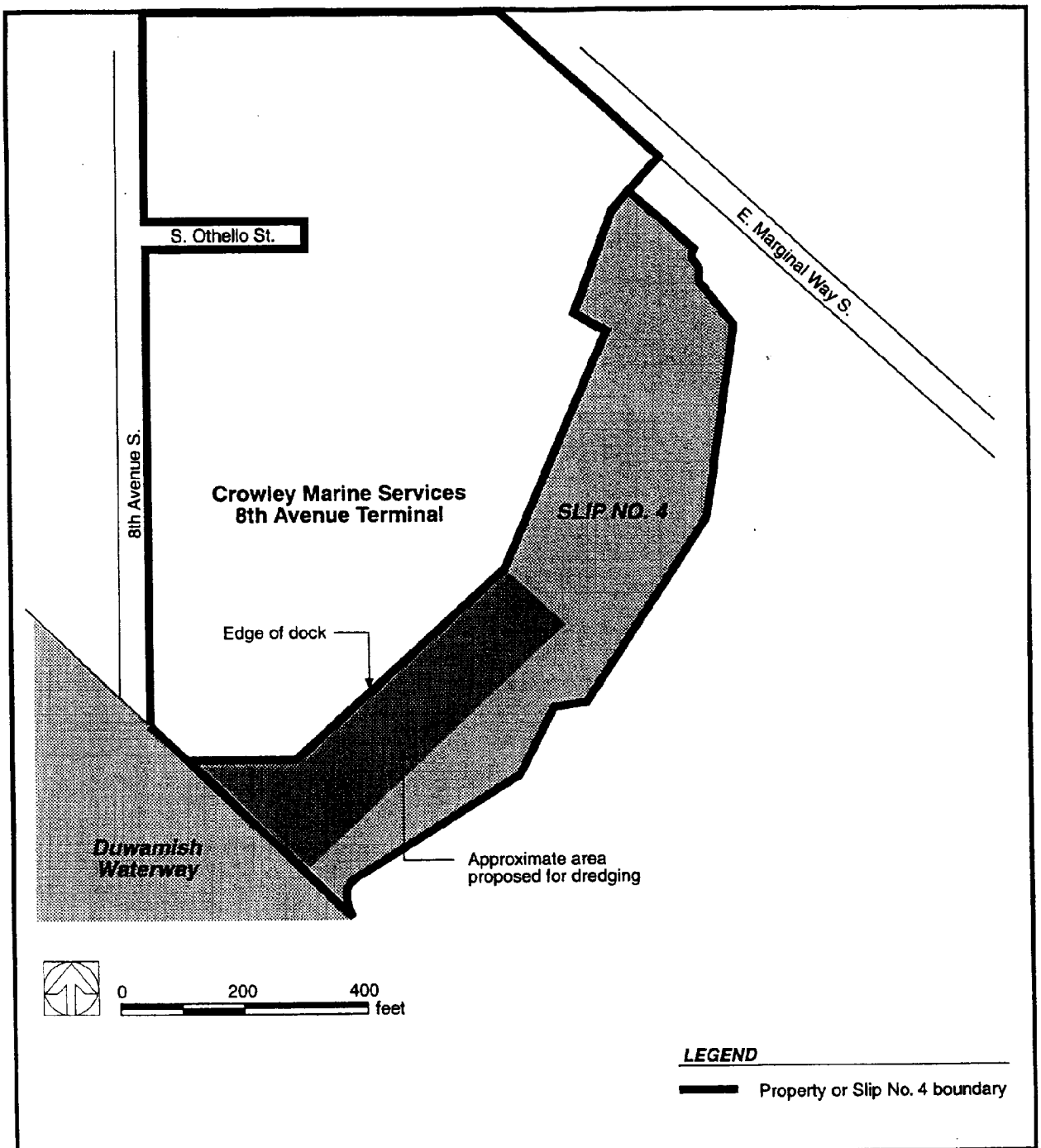


Figure 2.
Location of Slip No. 4.

Crowley Marine Services
8th Avenue Terminal
7400 8th Ave. S.
Seattle, WA 98108

PROPOSED DREDGING

IN: Slip No. 4, Duwamish Waterway

AT: Seattle

COUNTY OF: King STATE: WA

APPLICATION BY:
Crowley Marine Services

SHEET: DATE: 03/29/95

C483-06-02 05/12/95

KCSlip4 59500

SEA425799

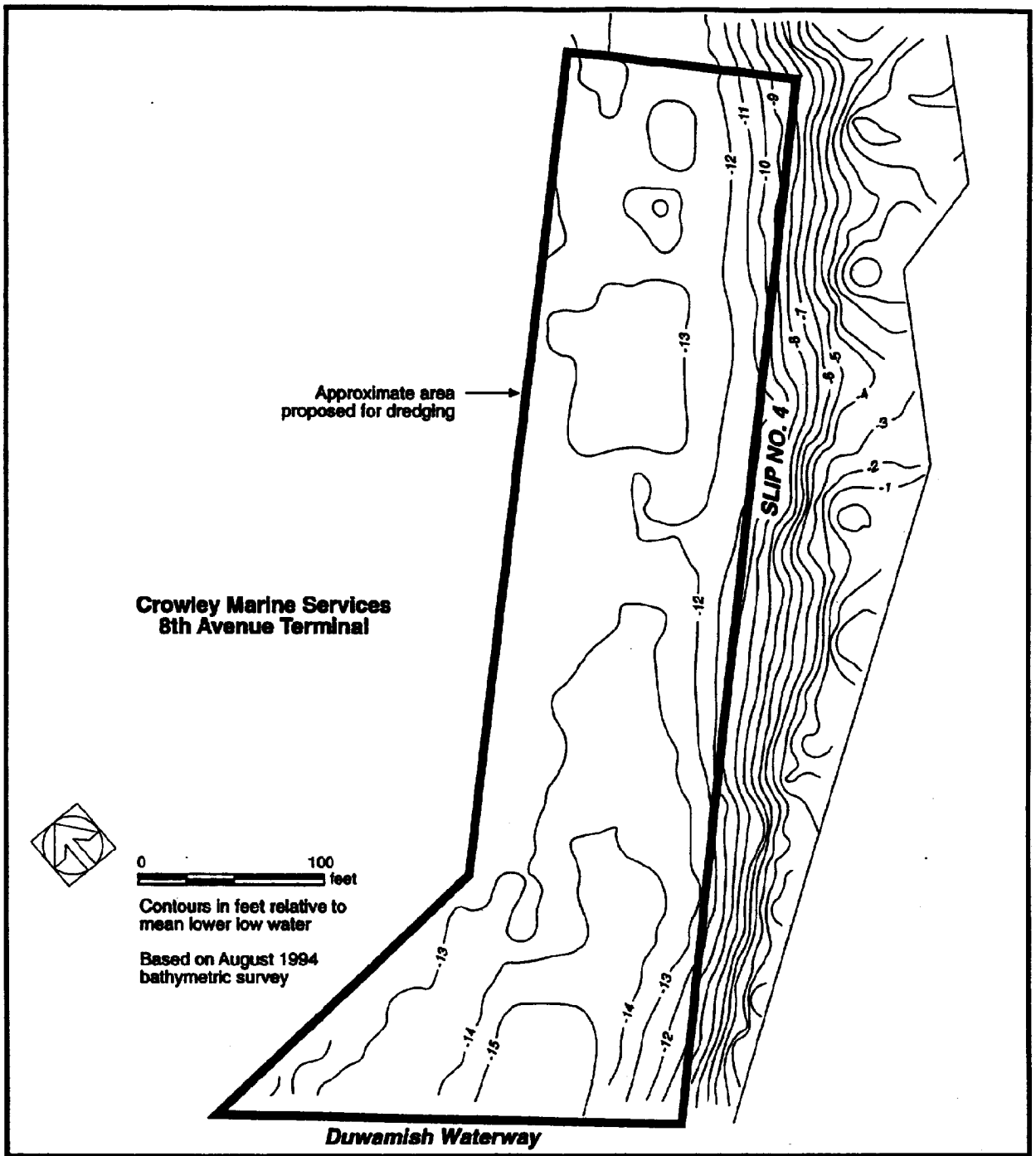


Figure 3.
Bathymetric contours of the area proposed for dredging.

Crowley Marine Services
8th Avenue Terminal
7400 8th Ave. S.
Seattle, WA 98108

PROPOSED DREDGING

IN: Slip No. 4, Duwamish Waterway

AT: Seattle

COUNTY OF: King STATE: WA

APPLICATION BY:
Crowley Marine Services

SHEET: DATE: 03/29/95

C483-06-02 05/12/95

KCSlip4 59501

SEA425800

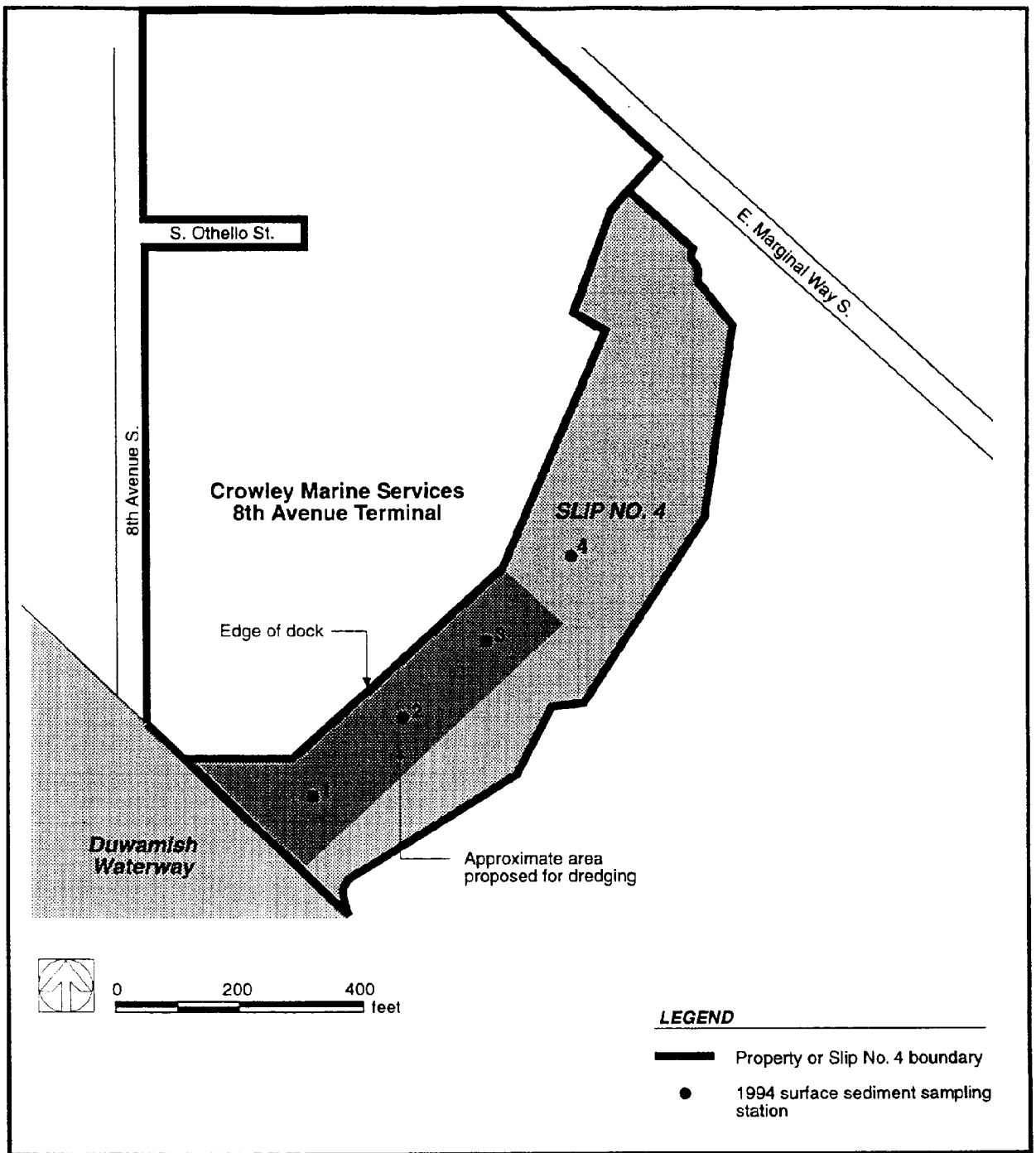


Figure 4.
1994 surface sediment sampling stations.

Crowley Marine Services
8th Avenue Terminal
7400 8th Ave. S.
Seattle, WA 98108

PROPOSED DREDGING

IN: Slip No. 4, Duwamish Waterway

AT: Seattle

COUNTY OF: King STATE: WA

APPLICATION BY:
Crowley Marine Services

SHEET: DATE: 03/29/95

C483-06-02 05/12/95

KCSlip4 59502

SEA425801

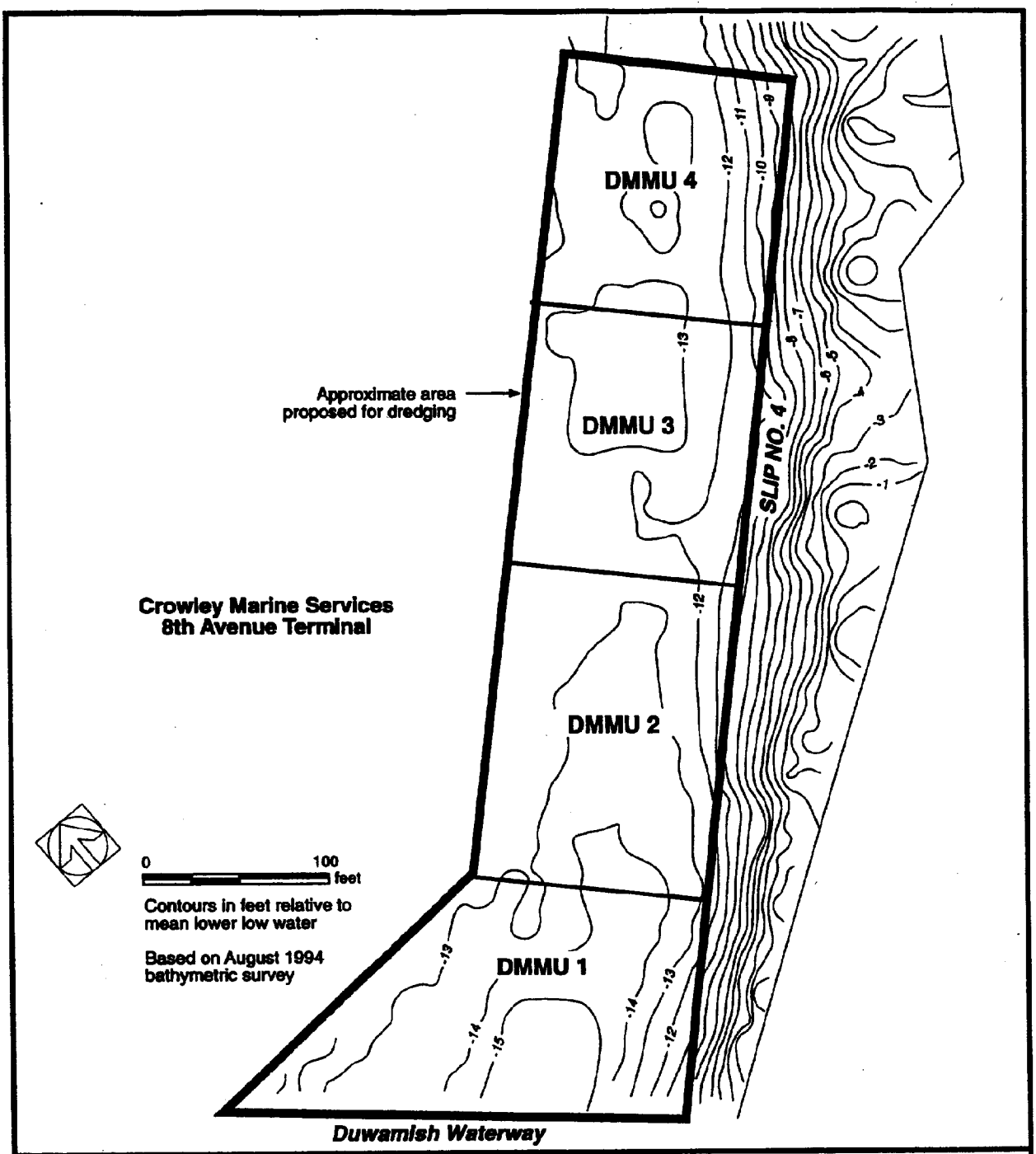


Figure 5.
Dredged material management units (DMMUs).

Crowley Marine Services
8th Avenue Terminal
7400 8th Ave. S.
Seattle, WA 98108

PROPOSED DREDGING

IN: Slip No. 4, Duwamish Waterway

AT: Seattle

COUNTY OF: King STATE: WA

APPLICATION BY:
Crowley Marine Services

SHEET: DATE: 03/29/95

C483-06-02 05/12/95

KCSlip4 59503

SEA425802

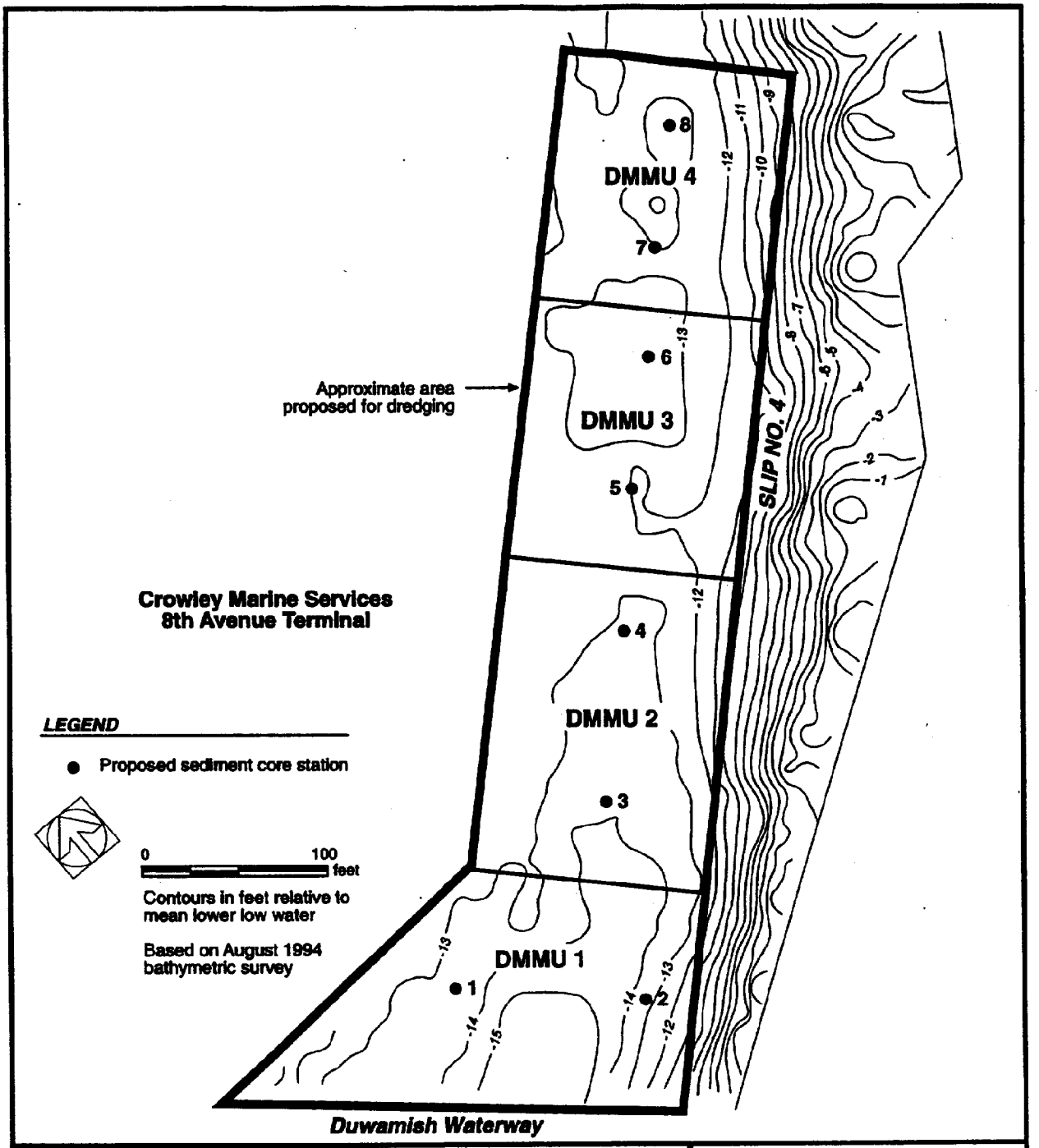


Figure 6.
Proposed sediment core station locations.

Crowley Marine Services
8th Avenue Terminal
7400 8th Ave. S.
Seattle, WA 98108

PROPOSED DREDGING

IN: Slip No. 4, Duwamish Waterway

AT: Seattle

COUNTY OF: King STATE: WA

APPLICATION BY:
Crowley Marine Services

SHEET: DATE: 03/29/95

C483-06-02 05/12/95

KCSlip4 59504

SEA425803

Tables

TABLE 1. COMPARISON OF CHEMICAL RESULTS FOR 1994 SEDIMENT SAMPLES TO PSDDA SCREENING LEVELS AND MAXIMUM LEVELS

Chemical	Station 1	Station 2	Station 3	Station 4	PSDDA SL	PSDDA ML
Metals (mg/kg dry weight)						
Antimony	0.8	1.2	1.1	1.8	20	200
Arsenic	11	10	12	18	57	700
Cadmium	0.4	0.4	0.4	0.8	0.96	9.6
Copper	55	51	47	74	81	810
Lead	31	37	35	59	66	660
Mercury	0.1	0.12	0.11	0.22	0.21	2.1
Nickel	27	29	27	29	140	--
Silver	0.4	0.3	0.3	0.6	1.2	6.1
Zinc	124	125	125	154	160	1,600
Organic Compounds (µg/kg dry weight)[a]						
Polycyclic aromatic hydrocarbons						
Total LPAH[b]	710	1,227	518	488	610	6,100
Naphthalene	46	28	23	24	210	2,100
Acenaphthylene	17 *U*	18 *U*	16 *U*	22 *U*	64	640
Acenaphthene	100	89	32	23	63	630
Fluorene	77	100	37	37	64	640
Phenanthrene	430	860	340	350	320	3,200
Anthracene	57	150	86	54	130	1,300
2-Methylnaphthalene	17 *U*	18 *U*	16 *U*	22 *U*	67	670
Total HPAH[c]	3077	4,915	2585	3340	1,800	51,000
Fluoranthene	660	1,400	560	620	630	6,300
Pyrene	670	940	500	510	430	7,300
Benzo[a]anthracene	380	660	340	320	450	4,500
Chrysene	300	390	290	360	670	6,700
Total benzofluoranthenes[d]	640	940	520	960	800	8,000
Benz[a]pyrene	210	320	200	300	680	6,800
Indeno[1,2,3-cd]pyrene	100	130	79	120	69	5,200
Dibenz[a,h]anthracene	46	47	43	64	120	1,200
Benzo[ghi]perylene	71	88	53	86	540	5,400
Chlorinated benzenes						
1,3-Dichlorobenzene	17 *U*	18 *U*	16 *U*	22 *U*	170	--
1,4-Dichlorobenzene	17 *U*	18 *U*	16 *U*	22 *U*	26	260
1,2-Dichlorobenzene	17 *U*	18 *U*	16 *U*	22 *U*	19	350
1,2,4-Trichlorobenzene	17 *U*	18 *U*	16 *U*	22 *U*	13	64
Hexachlorobenzene	17 *U*	18 *U*	16 *U*	22 *U*	23	230
Phthalate esters						
Dimethyl phthalate	17 *U*	18 *U*	16 *U*	22 *U*	160	--
Diethyl phthalate	17 *U*	18 *U*	16 *U*	22 *U*	97	--
Di-*n*-butyl phthalate	17 *U*	18 *U*	16 *U*	34	1,400	--
Butyl benzyl phthalate	17 *U*	18 *U*	17	22 *U*	470	--
bis[2-ethylhexyl]phthalate	240 *UB*	190 *UB*	290 *UB*	410 *UB*	3,100	--
Di-*n*-octyl phthalate	17 *U*	18 *U*	16 *U*	22 *U*	6,200	--

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TABLE 1. (cont.)

Chemical	Station 1	Station 2	Station 3	Station 4	PSDDA SL	PSDDA ML
Phenols						
Phenol	33 U	35 U	32 U	44 U	120	1,200
2–Methylphenol	17 U	18 U	16 U	22 U	20	72
4–Methylphenol	17 U	18 U	16 U	22 U	120	1,200
2,4–Dimethylphenol	33 U	35 U	32 U	44 U	29	50
Pentachlorophenol	83 U	88 U	80 U	110 U	100	690
Miscellaneous extractable compounds						
Benzyl alcohol	83 U	88 U	80 U	110 U	25	73
Benzoic acid	170 U	180 U	160 U	220 U	400	690
Dibenzofuran	72	65	30	29	54	540
Hexachloroethane	33 U	35 U	32 U	44 U	1,400	14,000
Hexachlorobutadiene	33 U	35 U	32 U	44 U	29	290
N–Nitrosodiphenylamine	17 U	18 U	16 U	22 U	28	220
Pesticides						
Total DDT[e]	3.3 U	4.4 U	4.0 U	8.8 U	6.9	69
Aldrin	2.8 U	5.4 U	4.6 U	7.7 U	10	--
Total chlordane[f]	4.5 U	8.7 U	5.6 U	8.2 U	10	--
Dieldrin	5.1 U	7.8 U	6.6 U	20 U	10	--
Heptachlor	0.73 U	1.4 U	0.87 U	0.93 U	10	--
Lindane	0.83 U	0.87 U	0.40 U	0.55 U	10	--
Total polychlorinated biphenyls	96	160	430	680	130	2500

Note -- – no maximum level has been established for these chemicals
HPAH – high molecular weight polycyclic aromatic hydrocarbons
LPAH – low molecular weight polycyclic aromatic hydrocarbons
ML – PSDDA maximum level
PSDDA – Puget Sound Dredged Disposal Analysis program
SL – PSDDA screening level
Outlined values indicate exceedance of SLs.
There were no exceedances of MLs.

[a] Where SLs and MLs in this table represent the sums of individual compounds (e.g., total LPAHs and total HPAHs) or groups of isomers (e.g., total PCBs), and a chemical analysis identified an undetected value for one or more individual compounds or groups of isomers, only the detected concentrations are used for calculating the sum of the respective compounds or groups of isomers. When all individual compounds or groups of isomers are undetected, the highest individual detection limit is reported.

[b] Total LPAH represents the sum of the concentrations of the following LPAH compounds: naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, and 2–methylnaphthalene. The total LPAH SLs and MLs are not the sums of the corresponding SLs and MLs listed for the individual LPAH compounds.

[c] Total HPAH represents the sum of the concentrations of the following HPAH compounds: fluoranthene, pyrene, benz[a]anthracene, chrysene, total benzofluoranthenes, benzo[a]pyrene, indeno[1,2,3–cd]pyrene, dibenz[a,h]anthracene, and benzo[ghi]perylene. The total HPAH SLs and MLs are not the sums of the corresponding SLs and MLs listed for the individual HPAH compounds.

[d] Total benzofluoranthenes represents the sum of the concentrations of the b, j, and k isomers of benzofluoranthene.

[e] Total DDT represents the sum of para, para'–DDD, DDE, and DDT.

[f] Total chlordane represents the sum of the alpha and gamma isomers.

TABLE 2. SLIP NO. 4 SEDIMENT SAMPLING STATIONS, BORE LENGTHS, AND CORE SECTIONS

Sediment Sampling Station	Estimated Existing Depth (ft MLLW)	Length of Sediment Bore (ft)	Core Section Designations and Depths (ft)
1	−13.3	4.7	A −13.3 to −17.0
			B −17.0 to −18.0
2	−13.5	4.5	A −13.5 to −17.0
			B −17.0 to −18.0
3	−13.2	4.8	A −13.2 to −17.0
			B −17.0 to −18.0
4	−13.0	5.0	A −13.0 to −17.0
			B −17.0 to −18.0
5	−12.0	6.0	A −12.0 to −17.0
			B −17.0 to −18.0
6	−13.5	4.5	A −13.5 to −17.0
			B −17.0 to −18.0
7	−11.7	6.3	A −11.7 to −17.0
			B −17.0 to −18.0
8	−13.3	4.7	A −13.3 to −17.0
			B −17.0 to −18.0

Note: MLLW - mean lower low water

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TABLE 3. SLIP NO. 4 SEDIMENT SAMPLE DISPOSITION

DMMU	Samples to be Analyzed: Samples Composited	Samples to be Analyzed: Estimated Sediment Volume Represented (yd^3)	Samples to be Archived
1	1A, 2A	3,250	1B, 2B
2	3A, 4A	3,250	3B, 4B
3	5A, 6A	3,250	5B, 6B
4	7A, 8A	3,250	7B, 8B

Note: DMMU - dredged material management unit

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TABLE 4. SAMPLE CONTAINERS, PREPARATION, AND PRESERVATIVES

Parameter Group	Container	Approximate Laboratory Subsample[a]	Container Preparation	Holding Time (days)	Preservative and Handling
Semivolatile, pesticides, and PCB organic compounds	One 500-mL wide-mouth glass jar; Teflon®-lined lid	50–100 g	Detergent wash; acid, deionized water, and solvent rinses; oven dry at 105°C	10	Keep in dark; cool (4°C)
				1 year	Keep in dark; freeze (−20°C)
Volatile organic compounds	One 60-mL wide-mouth glass jar; Teflon®-lined lid	5 g	Detergent wash; distilled water rinse; oven dry at 105°C	10	Fill bottle with no head space; keep in dark; cool (4°C)
Metals, ammonia, total volatile solids, and total solids	One 250-mL high-density polyethylene jar	3 g (metals) 20 g (ammonia) 10 g (total volatile solids) 10 g (total solids)	Detergent wash; acid rinse; multiple deionized water rinses; air dry	180[b,c]	Freeze (−20°C)[b,c]
Total organic carbon	One 125-mL high-density polyethylene jar or wide-mouth glass jar; Teflon®-lined lid	10 g	Detergent wash; acid, deionized water, and solvent rinses; oven dry at 105°C (glass jar only)	28	Cool (4°C) or Freeze (−20°C)
Grain size and percent moisture	One 250-mL high-density polyethylene jar	250 g (grain size) 10 g (percent moisture)	Detergent wash; deionized water rinse; air dry	28	Cool (4°C)
Total sulfides	One 250-mL high-density polyethylene jar	15 g	Detergent wash; deionized water rinse; air dry	7	Fill bottle with no head space; 2N zinc acetate; keep in dark; Cool (4°C)
Toxicity tests	Six 1-L wide-mouth glass jar; Teflon®-lined lid	–	Detergent wash; acid rinse; multiple deionized water rinses; air dry	14	Cool (4°C)

Note: PCB - polychlorinated biphenyl
Teflon® - tetrafluoroethylene

[a] Approximate laboratory subsample refers to amount of sample analyzed in the laboratory.

[b] Analyses for ammonia must be completed within 7 days from date of sample collection; samples stored at 4°C

[c] Analyses for mercury must be completed within 28 days from date of sample collection.

TABLE 5. MINIMUM LABORATORY QUALITY ASSURANCE AND QUALITY CONTROL REQUIREMENTS

Analysis Type	Method Blanks	Triplicates[a]	Replicates	CRM	Matrix Spike[a]	Surrogates[b]
Volatile organics[c,d]	X[e]		X[f,g]		X	X
Semivolatiles[c,d]	X[e]		X[f,g]	X	X	X
Pesticides/PCBs[c,d]	X[e]		X[f,g]	X	X	X
Metals	X[e]		X[e]	X	X	
Ammonia	X[e]	X				
Total sulfides	X[e]	X				
Total organic carbon	X[e]	X		X[h]		
Total solids		X				
Total volatile solids		X				
Particle size		X				

Note: CRM - certified reference material
PCB - polychlorinated biphenyl

[a] Frequency of analysis = 5 percent or 1 per batch, whichever is more frequent.

[b] Surrogate spikes are required for every sample, including matrix spiked samples, blanks, and reference materials.

[c] Initial calibration is required before any samples are analyzed, after each major disruption of equipment, and when ongoing calibration fails to meet criteria.

[d] Ongoing calibration is required at the beginning of each work shift, every 10-12 samples or every 12 hours (whichever is more frequent), and at the end of each work shift.

[e] Frequency of analysis = 1 per extraction batch.

[f] Frequency of analysis = <20 samples: 1 per batch; ≥20 samples: 1 triplicate and additional duplicates for a minimum of 5 percent total replication.

[g] A matrix spike duplicate will be run.

[h] Frequency of analysis = 1 per major survey.

Appendix A

Section 10/404 Draft Permit Application

JOINT APPLICATION FOR PERMITS

LOCAL GOVERNMENTS UNDER THE SHORELINE MANAGEMENT ACT

STATE OF WASHINGTON DEPARTMENTS OF ECOLOGY, WILDLIFE AND FISHERIES

U.S. ARMY CORPS OF ENGINEERS

This is a joint application for the following permits required for working in or near waters, shorelines or wetlands:

a. Shoreline Substantial Development, Conditional Use or Variance Permit issued by Local Government, under the Shoreline Management Act, 90.58 RCW;
b. Short Term Modification of Water Quality standards, issued by the Department of Ecology, under 90.48 RCW (excluding aquatic herbicide and pesticide applications);
c. Hydraulic Project Approval issued by the Departments of Fisheries and Wildlife under 75.20 RCW;
d. Section 401 Certification issued by the Department of Ecology under 33 USC §1341 (excluding hydropower development); and
e. Section 404 and Section 10 Permits issued by the U.S. Army Corps of Engineers under 33 USC §§ 401 and 1344.

PLEASE NOTE: *Other permits may be required which are not covered by this application form.*

AGENCY USE ONLY

Agency Reference #: _____ Date Received: _____

SEPA Lead Agency: _____

Distributed to Reviewing Agencies by: ☐ Applicant ☐ Local Government

Additional Distribution: TO: BY:

PLEASE TYPE OR PRINT

1. Applicant Crowley Marine Services, Inc. Attn: Stephen Wilson

   Mailing Address P O Box 2287

   Seattle, WA 98111-2287

   Work Phone: (206) 443-8042 Home Phone: ( )

   Fax Number: (206) 443-8621

2. Authorized Agent N/A

   Mailing Address _____

   Work Phone: ( ) _____ Home Phone: ( ) _____

   Fax Number: ( ) _____

3. Designation of Authorized Agent, if applicable:

   I hereby designate N/A to act as my agent in matters relat to this application for permit(s). I understand that if a Federal permit is issued, I must sign the permit.

   _____ _____

   Signature of Applicant Date

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4. Relationship of applicant to property: ☒ Owner ☐ Purchaser ☐ Lessee ☐ Other (_____

5. Name, address, and phone number of property owner, if other than applicant:

See response to #1 above.

6. Location where proposed activity exists or will occur. Name of local govt. City of Seattle

Street Address (if applicable): 7400 8th Ave South, Seattle, WA 98108

Waterbody: Slip 4, Duwamish Waterway Tributary of: _____

Shoreline Environment Designation: Urban-Industrial Zoning Designation: _____

In or near city or town: Seattle

King WA

County State Zip Code

Tax Parcel No.: #292404-9110-03

SE Qtr of 29 24N 4E W.M

1/4 1/4 Section Township Range

7. Current use of property with existing structures and/or improvements:

See attached.

8. a. Describe the proposed activity, and the activity's purpose. Include method of construction, type of material, expected impacts to aquatic resources, and proposed actions to reduce the duration and severity of those impacts. If additional space is needed, use a separate sheet.

See attached.

8. b. List all soil series located at project site, and indicate if any are on the county's list of hydric soils:

8. c. • Will rock, fill, bulkhead, pilings or other material be placed waterward of Ordinary High Water Mark or Line for fresh or tidal waters? ☐ Yes ☒ No

i. If "yes," in fresh water indicate volume in cubic yards: _____

ii. If "yes," in tidal waters, indicate volume in cubic yards waterward of the line of mean higher high water: _____

• Will material be placed in wetlands? ☐ Yes ☒ No *If yes*, impacted area: _____(acre

i. Type and composition of fill material (e.g., sand, etc.): _____

ii. Material source: _____

• Will proposed activity cause flooding or draining of wetlands? ☐ Yes ☒ No *If yes*, impacted area: _____(acr

• Will excavation be required? ☒ Yes ☐ No *If yes, volume:* 12,080 (cubic yard

i. Composition: Silty Sediment

ii. Disposal site for excavated material: Either PSDDA open-water or upland disposa

iii. Method of dredging: Clamshell dredge depending on chemical and biological testing.

8. d. Will any structures be placed:

i. waterward of the Ordinary High Water Mark or Line for fresh or tidal waters? ☐ Yes ☒ No

ii. waterward of Mean High Water Line in tidal waters? ☐ Yes ☒ No

8. e. Estimated cost of the full proposal (fair market value): Approximately $100,000 (includes dredging and disposal)

8. f. Preparation of drawings: One set of original or good quality reproducible drawings must be attached to this application. ***NOTE:*** THE CORPS OF ENGINEERS REQUIRES DRAWINGS ON 8-1/2 X 11 INCH SHEETS. See the instruction pamphlet for instructions and a checklist for completing the drawings. Applicants are encouraged to submit photographs of the project site, but these do not substitute for drawings. Larger drawings may be required by other agencies.

9. Proposed Starting Date: November 1995 Estimated duration of activity: 3 weeks

10. If any portion of the activity has been completed, indicate month and year of completion: N/A

Indicate the existing work on the drawings. List any future work for this site, not covered by this application:

11. For public notice purposes, provide names, addresses, and telephone numbers of adjoining property owners, lessees, etc.

Markey Machinery Co Inc	7266 8th Ave S 98108	622-4697
Puget Sound Freight Lines	3720 Airport Way S 98108	623-1600
Boeing Aircraft Co	7755 E Marginal Way S 98108	655-2121
Evergreen Marine Leasing First Interstate Bank	PO Box 160-MS-247 98111	

PLEASE NOTE: Shoreline management compliance may require additional notice — consult your local government.

12. List other applications, approvals, or certifications from other Federal, state or local agencies for any structures, construction, discharges, or other activities described in the application (i.e., preliminary plat approval, health district approval, building permit, SEPA review, FERC license, Forest Practices Application, etc.)

Issuing Agency	Type of Approval	Identification No.	Date of Application	Date Approved
None submitted yet				

13. Has any agency denied approval for the activity described herein or for any activity directly related to the activity described herein? ☐ Yes ☒ No *If yes*, explain:

14. Application is hereby made for a permit or permits to authorize the activities described herein. I certify that I am familiar with the information contained in this application, and that to the best of my knowledge and belief, such information is true, complete, and accurate. I further certify that I possess the authority to undertake the proposed activities. I hereby grant to the agencies to which this application is made, the right to enter the above-described location to inspect the proposed or completed work.

R Starke Loft — April 10, 1995

Signature of Applicant or Authorized Agent (REQUIRED) — Date

Signature of Landowner (REQUIRED if other than applicant) — Date

This application must be signed by the applicant. If an authorized agent is to be designated, the applicant must sign at Item #3.

15. Copies of this application are being sent to:

- ☐ Local Government for: *(check all that apply)* ☐ SDP ☐ Conditional Use ☐ Variance ☐ Exemption
- ☐ Washington Department of Fisheries or Wildlife for HPA
- ☐ Washington Department of Ecology for Short Term Modification to Water Quality Standards, and/or 401 Water Quality Certification for those Nationwide Permits listed in the instruction pamphlet
- ☒ Corps Engineers for Section 404 or Section 10 permit(s)

18 U.S.C §1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of the United States knowingly falsifies, conceals, or covers up by any trick, scheme, or device a material fact or makes any false, fictitious, or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious, or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than 5 years or both.

DO NOT SEND FEDERAL PROCESSING FEE WITH APPLICATION

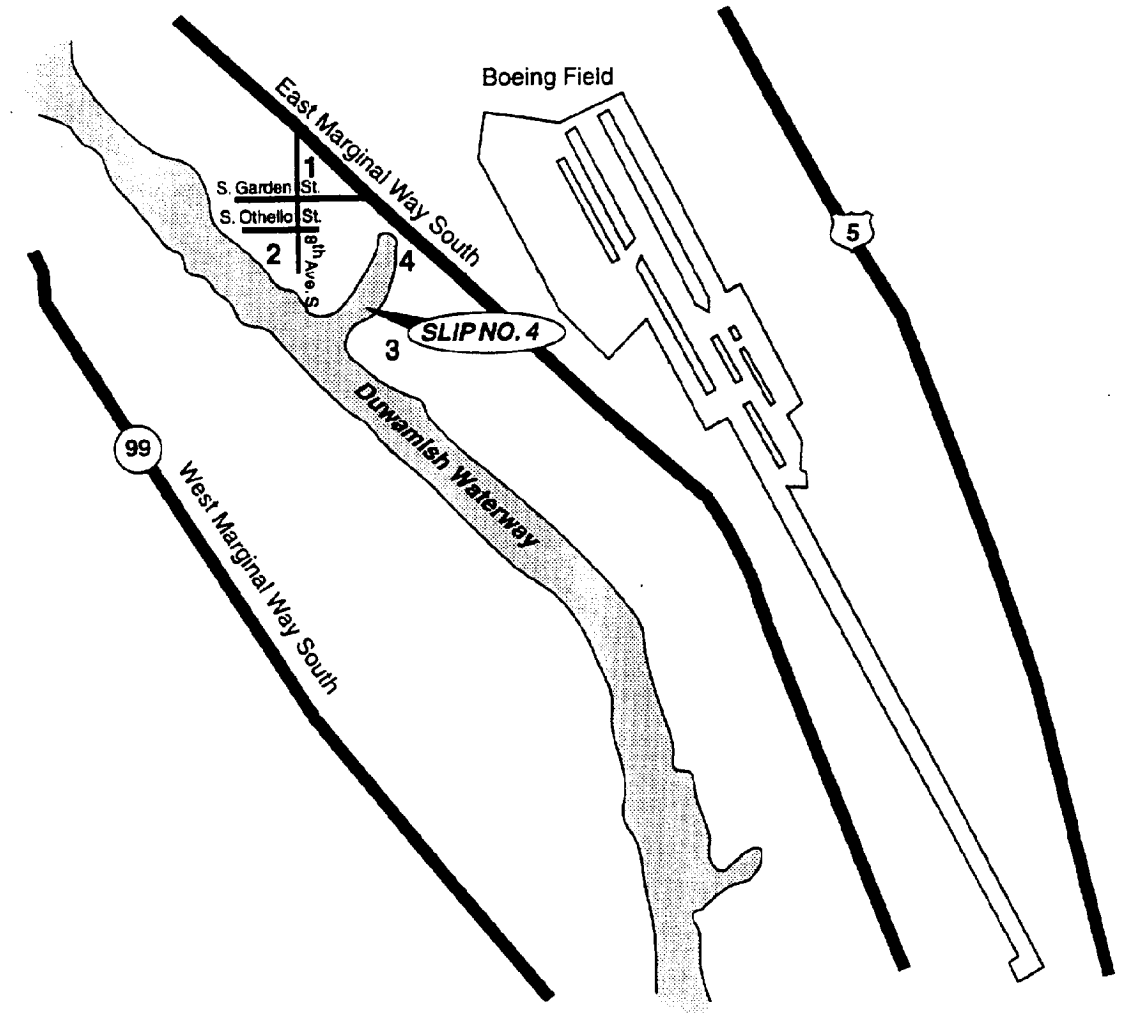
TO BE COMPLETED BY LOCAL OFFICIAL

A. Nature of the existing shoreline. (Describe type of shoreline, such as marine, stream, lake, lagoon, marsh, bog, swamp, flood plain, floodway, delta; type of beach, such as accretion, erosion, high bank, low bank, or dike; material such as sand, gravel, mud, clay, rock, riprap; and extent and type of bulkheading, if any:) _____

B. In the event that any of the proposed buildings or structures will exceed a height of thirty-five feet above the average grade level, indicate the approximate location of and number of residential units, existing and potential, that will have an obstructed view: _____

C. If the application involves a conditional use or variance, set forth in full that portion of the master program which provides that the proposed use may be a conditional use, or, in the case of a variance, from which the variance is being sought: _____

These Agencies are Equal Opportunity and Affirmative Action employers.
For special accommodation needs, please contact the appropriate agency from Appendix A.



ADJACENT PROPERTY OWNERS OR LESSEES:

1. Markey Machinery Co., Inc.
   7266 8th Ave. S.
   Seattle, WA 98108
2. Puget Sound Freight Lines
   3720 Airport Way S.
   Seattle, WA 98108
3. Boeing Aircraft Co., Inc.
   7755 E. Marginal Way S.
   Seattle, WA 98108
4. Evergreen Marine Leasing
   First Interstate Bank
   P.O. Box 160-MS-247
   Seattle, Wa 98111

Figure 1. Vicinity map.

Crowley Marine Services
8th Avenue Terminal
7400 8th Ave. S.
Seattle, WA 98108

PROPOSED DREDGING

IN: Slip No. 4, Duwamish Waterway

AT: Seattle

COUNTY OF: King STATE: WA

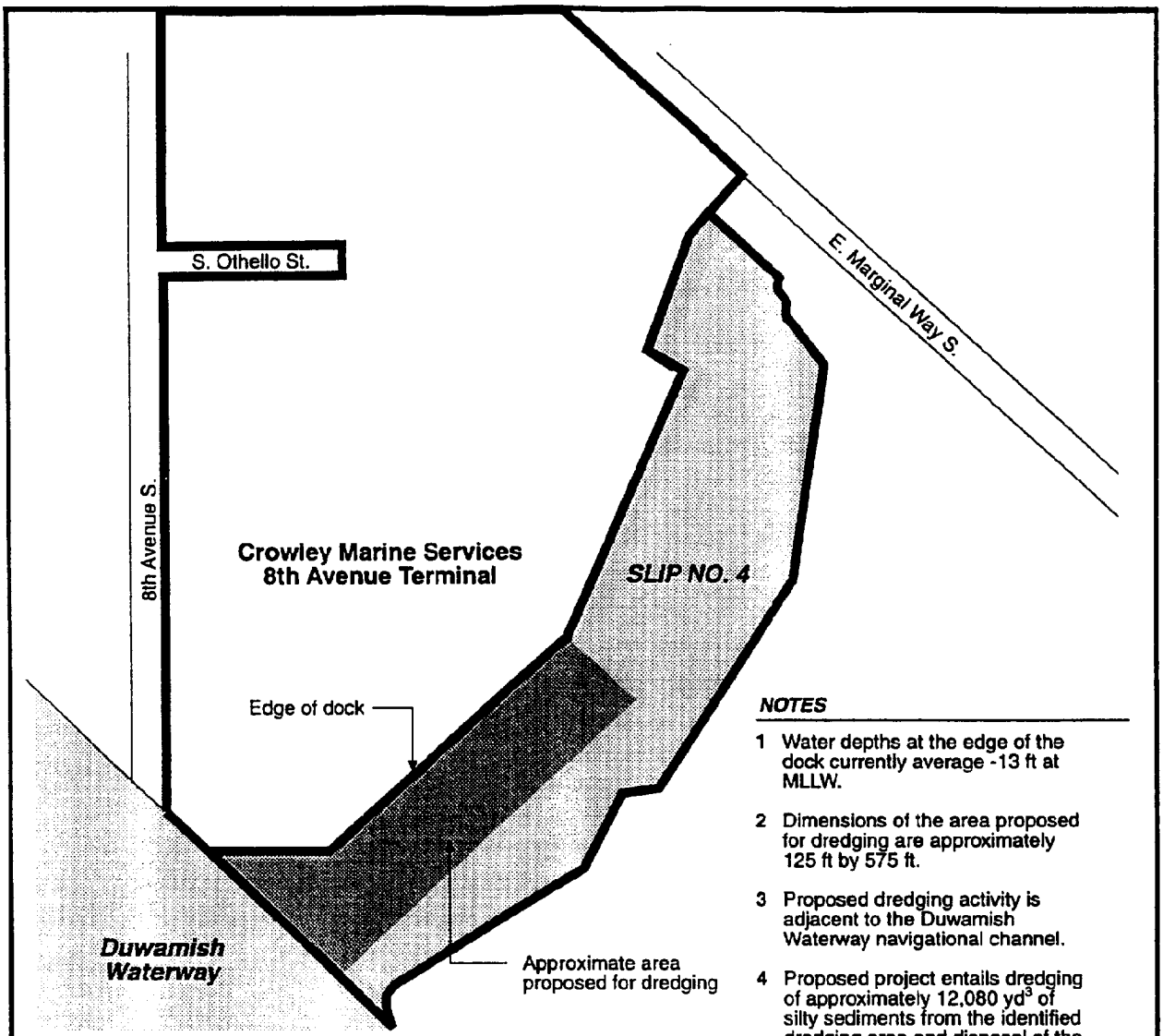
APPLICATION BY:
Crowley Marine Services

SHEET: DATE: 03/29/95

C483-09-01 03/29/95

KCSlip4 59517

SEA425816



NOTES

1 Water depths at the edge of the dock currently average -13 ft at MLLW.

2 Dimensions of the area proposed for dredging are approximately 125 ft by 575 ft.

3 Proposed dredging activity is adjacent to the Duwamish Waterway navigational channel.

4 Proposed project entails dredging of approximately 12,080 yd^3 of silty sediments from the identified dredging area and disposal of the material at either an approved PSDDA open-water disposal site or an upland disposal site, depending on the results of chemical and biological testing.

LEGEND

Property or Slip No. 4 boundary

ADJACENT PROPERTY OWNERS OR LESSEES:

1 Markey Machinery Co., Inc.
7266 8th Ave. S.
Seattle, WA 98108

2 Puget Sound Freight Lines
3720 Airport Way S.
Seattle, WA 98108

3 Boeing Aircraft Co., Inc.
7755 E. Marginal Way S.
Seattle, WA 98108

4 Evergreen Marine Leasing
First Interstate Bank
P.O. Box 160-MS-247
Seattle, Wa 98111

Figure 2. Plan view.

Crowley Marine Services
8th Avenue Terminal
7400 8th Ave. S.
Seattle, WA 98108

PROPOSED DREDGING

IN: Slip No. 4, Duwamish Waterway

AT: Seattle

COUNTY OF: King STATE: WA

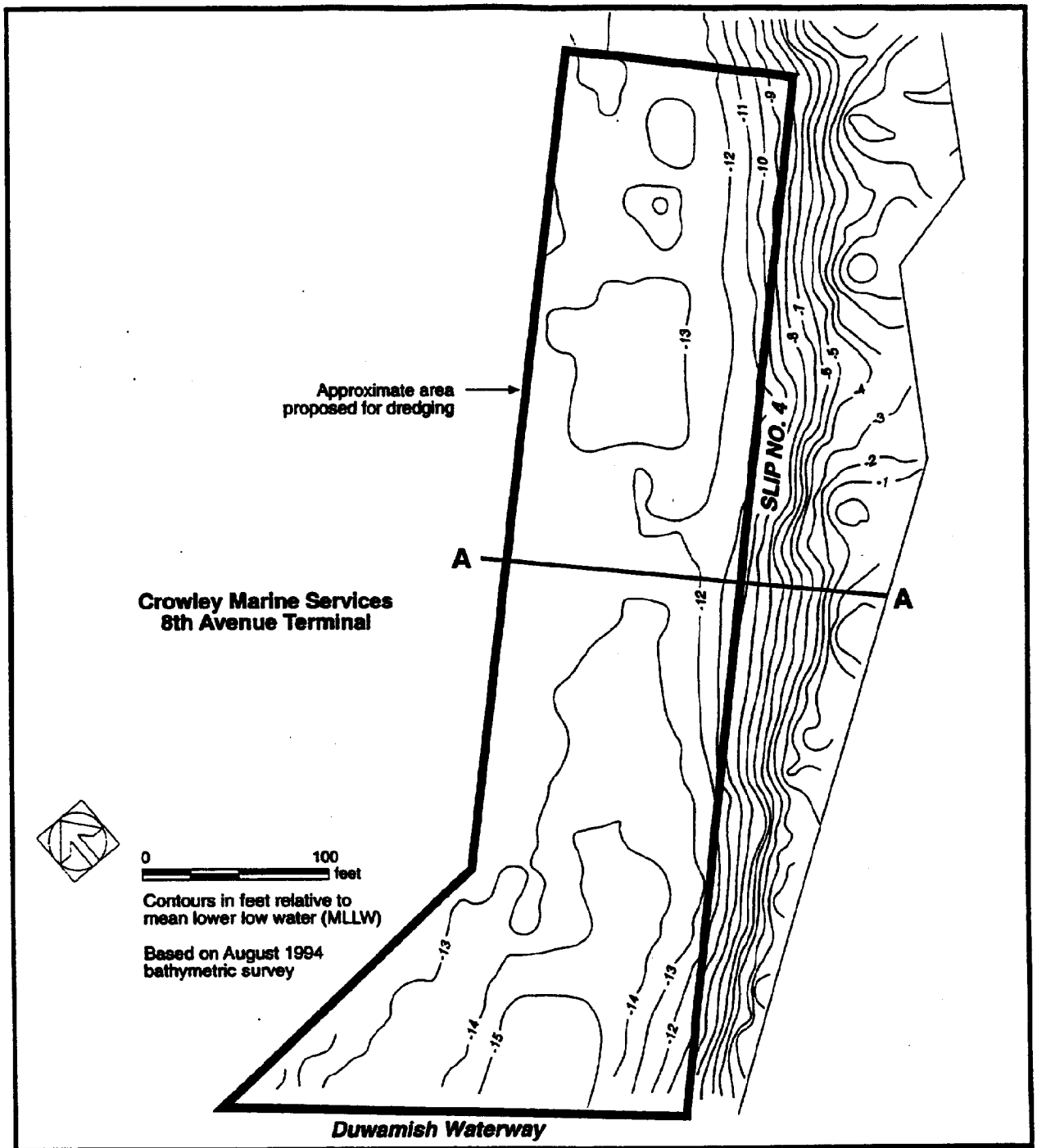
APPLICATION BY:
Crowley Marine Services

SHEET: DATE: 03/29/95

C483-09-01 03/29/95

KCSlip4 59518

SEA425817



ADJACENT PROPERTY OWNERS OR LESSEES:

1. Markey Machinery Co., Inc.
   7266 8th Ave. S.
   Seattle, WA 98108
2. Puget Sound Freight Lines
   3720 Airport Way S.
   Seattle, WA 98108
3. Boeing Aircraft Co., Inc.
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   Seattle, WA 98108
4. Evergreen Marine Leasing
   First Interstate Bank
   P.O. Box 160-MS-247
   Seattle, Wa 98111

Figure 3.
Approximate area proposed for dredging.

Crowley Marine Services
8th Avenue Terminal
7400 8th Ave. S.
Seattle, WA 98108

PROPOSED DREDGING

IN: Slip No. 4, Duwamish Waterway

AT: Seattle

COUNTY OF: King STATE: WA

APPLICATION BY:
Crowley Marine Services

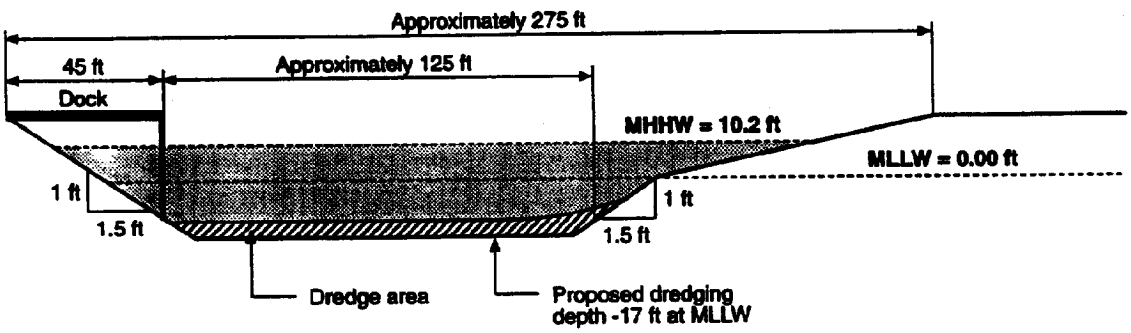
SHEET: DATE: 03/29/95

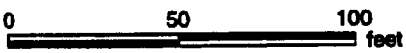
C483-09-01 03/29/95

KCSlip4 59519

SEA425818

SECTION A-A





ADJACENT PROPERTY OWNERS OR LESSEES:

1. Markey Machinery Co., Inc.
   7266 6th Ave. S.
   Seattle, WA 98108
2. Puget Sound Freight Lines
   3720 Airport Way S.
   Seattle, WA 98108
3. Boeing Aircraft Co., Inc.
   7755 E. Marginal Way S.
   Seattle, WA 98108
4. Evergreen Marine Leasing
   First Interstate Bank
   P.O. Box 160-MS-247
   Seattle, Wa 98111

Figure 4.
Cross section view.

Crowley Marine Services
8th Avenue Terminal
7400 8th Ave. S.
Seattle, WA 98108

PROPOSED DREDGING

IN: Slip No. 4, Duwamish Waterway

AT: Seattle

COUNTY OF: King STATE: WA

APPLICATION BY:
Crowley Marine Services

SHEET: DATE: 03/29/95

C483-09-01 03/29/95

APPLICATION FOR DEPARTMENT OF THE ARMY PERMIT (33 CFR 325)	OMB APPROVAL NO. 0710-003 Expires October 1998

ublic reporting burden for this collection of information is estimated to average 6 hours per response, including the time for reviewing instructions, r ching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send : ments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to epartment of Defense, Washington Headquarters Service Directorate of InformationOperations and Reports, 1215 Jefferson Davis Highway, Suite 204, Arlington, VA 22202-4302; and to the Office of Management and Budget, Paperwork Reduction Project (0710-0003), Washington, DC 03. Please DO NOT RETURN your form to either of those addresses. Completed applications must be submitted to the District Engineer having diction over the location of the proposed activity.

PRIVACY ACT STATEMENT

thority: 33 USC 401, Section 10; 1413, Section 404. Principal Purpose: These laws require permits authorizing activities in, or affecting, gable waters of the United States, the discharge of dredged or fill material into waters of the United States, and the transportation of dredged terial for the purpose of dumping it into ocean waters. Routine Uses: Information provided on this form will be used in evaluating the application for a permit. Disclosure: Disclosure of requested information is voluntary. If information is not provided, however, the permit application cannot be processed nor can a permit be issued.

e set of original drawings or good reproducible copies which show the location and character of the proposed activity must be attached to this pplication (see sample drawings and instructions) and be submitted to the District Engineer having jurisdiction over the location of the proposed ctivity. An application that is not completed in full will be returned.

(ITEMS 1 THRU 4 TO BE FILLED BY THE CORPS)

1. APPLICATION NO.	2. FIELD OFFICE CODE	3. DATE RECEIVED	4. DATE APPLICATION COMPLETED

(ITEMS BELOW TO BE FILLED BY APPLICANT)

5. APPLICANT'S NAME	8. AUTHORIZED AGENT'S NAME AND TITLE (an agent is not required)
Attn: Stephen Crowley Marine Services Wilson	N/A
6. APPLICANT'S ADDRESS	**9. AGENT'S ADDRESS**
PO Box 2287 Seattle, WA 98111-2287	N/A
7. APPLICANT'S PHONE NOS. W/AREA CODE	**10. AGENT'S PHONE NOS. W/AREA CODE**
a. Residence	a. Residence N/A
b. Business (206) 443-8042	b. Business N/A

STATEMENT OF AUTHORIZATION

I hereby authorize, N/A to act in my behalf as my agent in the processing of this application and to furnish, upon request, supplemental information in support of this permit application.

APPLICANT'S SIGNATURE DATE

NAME, LOCATION AND DESCRIPTION OF PROJECT OR ACTIVITY

12. PROJECT NAME OR TITLE (see instructions)

Maintenance dredging, Slip No. 4, Duwamish Waterway

13. NAME OF WATERBODY, IF KNOWN (if applicable)	14. PROJECT STREET ADDRESS (if applicable)
Slip No. 4, Duwamish Waterway	Crowley Marine Services 8th Avenue Terminal 7400 8th Ave S Seattle, WA 98108
15. LOCATION OF PROJECT	
King (COUNTY) WA (STATE)	

16. OTHER LOCATION DESCRIPTIONS, IF KNOWN. (see instructions)

N/A

17. DIRECTIONS TO THE SITE

From Seattle, take East Marginal Way South to 8th Ave South. Turn right onto 8th Ave South. Crowley Marine Services 8th Ave Terminal will be on the east side of the road (see Figure 1).

KCSlip4 59521

SEA425820

See attached

19. Project Purpose (Describe the reason or purpose of the project, see instructions)

The purpose of this activity is to provide for continued access to the 8th Avenue Terminal facility by oceangoing barges and tugboats.

USE BLOCKS 20-22 IF DREDGED AND/OR FILL MATERIAL IS TO BE DISCHARGED

20. Reason(s) for Discharge

Depending on the results of biological and chemical testing, the dredged material may be disposed of at a PSDDA approved open-water disposal site.

21. Type(s) of Material Being Discharged and the Amount of Each Type in Cubic Yards

Approximately 12,080 y^3 of silty sediment.

22. Surface Area in Acres of Wetlands or Other Waters Filled (see instructions)

N/A

23. Is Any Portion of the Work Already Complete? Yes ____ No X IF YES, DESCRIBE THE COMPLETED WORK

24. Addresses of Adjoining Property Owners, Lessees, Etc., Whose Property Adjoins the Waterbody (If more than can be entered here, please attach a supplemental list).

Boeing Aircraft Co., 7755 E Marginal Way S, 98108 655-2121
Puget Sound Freight Lines, 3720 Airport Way S, 98108 623-1600

Evergreen Marine Leasing
First Interstate Bank PO Box 160-MS-247 98111

25. List of Other Certifications or Approvals/Denials Received from other Federal, State or Local Agencies for Work Described in This Application.

AGENCY	TYPE APPROVAL*	IDENTIFICATION NUMBER	DATE APPLIED	DATE APPROVED	DATE DENIED
No other applications have yet been submitted.					

*Would include but is not restricted to zoning, building and flood plain permits

26. Application is hereby made for a permit or permits to authorize the work described in this application. I certify that the information in this application is complete and correct. I further certify that I possess the authority to undertake the work described herein or am acting as the duly authorized agent of the applicant.

R Steele — April 19, 1995
SIGNATURE OF APPLICANT — DATE — SIGNATURE OF AGENT — DATE

The application must be signed by the person who desires to undertake the proposed activity (applicant) or it may be signed by a duly authorized agent if the statement in block 11 has been filled out and signed.

18 U.S.C. Section 1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of the United States knowingly and willfully falsifies, conceals, or covers up any trick, scheme, or disguises a material fact or makes any false, fictitious or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious or fraudulent statements or entry, shall be fined not more than $10,000 or imprisoned not more than five years or both.

*U.S.GPO:1994-630-478/80018

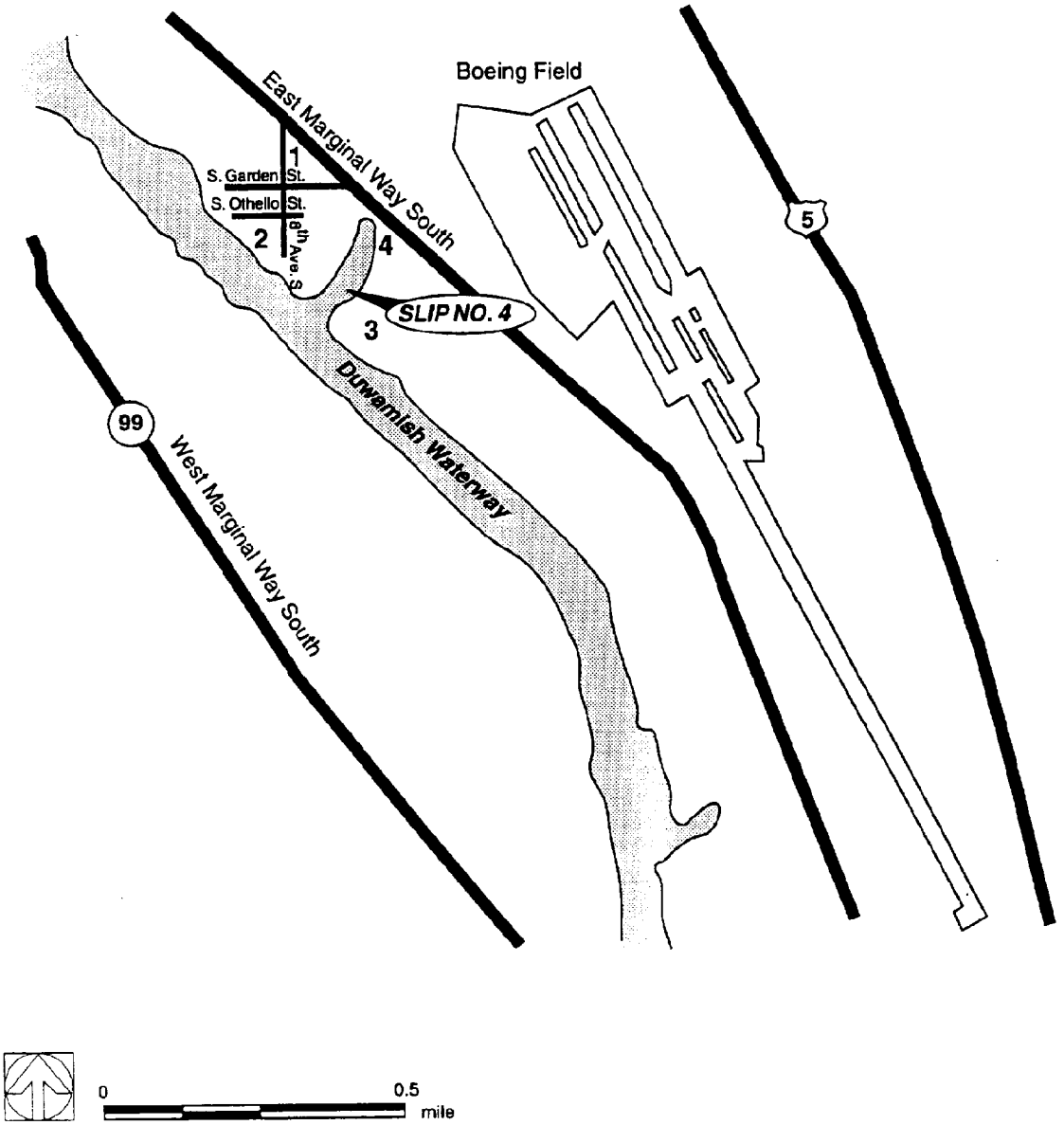
KCSlip4 59522

SEA425821

18. Maintenance dredging of approximately 12,080 yd^3 of silty sediment from the outer portion, western side, of Slip No. 4, as illustrated in Figure 2. The purpose of this activity is to provide for continued access to the 8th Avenue Terminal facility by oceangoing barges and tugboats. Dredging will entail the removal of approximately 2-5 feet of sediments within the defined area (approximately 575 ft by 125 ft) as required to achieve a final water depth of -17 ft MLLW (see Figure 3). Sediments will be dredged using a clamshell dredge. A silt curtain will be used to control turbidity if required. A cross section of the proposed dredging activity is provided in Figure 4.

Chemical and biological testing (i.e., sediment toxicity tests) of the sediments to be dredged is scheduled for spring, 1995. Depending on the analytical results of those tests, the dredged material will be loaded onto a barge and either disposed of at an unconfined, open-water disposal site under the Puget Sound Dredged Disposal Analysis program, or will be transferred to trucks for transport to an appropriate upland disposal facility.

Slip No. 4 is located in a highly industrialized area, and this dredging activity is not expected to cause any impacts to aquatic resources or sensitive habitat.



ADJACENT PROPERTY OWNERS OR LESSEES:

1. Markey Machinery Co., Inc.
   7266 8th Ave. S.
   Seattle, WA 98108
2. Puget Sound Freight Lines
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3. Boeing Aircraft Co., Inc.
   7755 E. Marginal Way S.
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   First Interstate Bank
   P.O. Box 160-MS-247
   Seattle, Wa 98111

Figure 1. Vicinity map.

Crowley Marine Services
8th Avenue Terminal
7400 8th Ave. S.
Seattle, WA 98108

PROPOSED DREDGING

IN: Slip No. 4, Duwamish Waterway

AT: Seattle

COUNTY OF: King STATE: WA

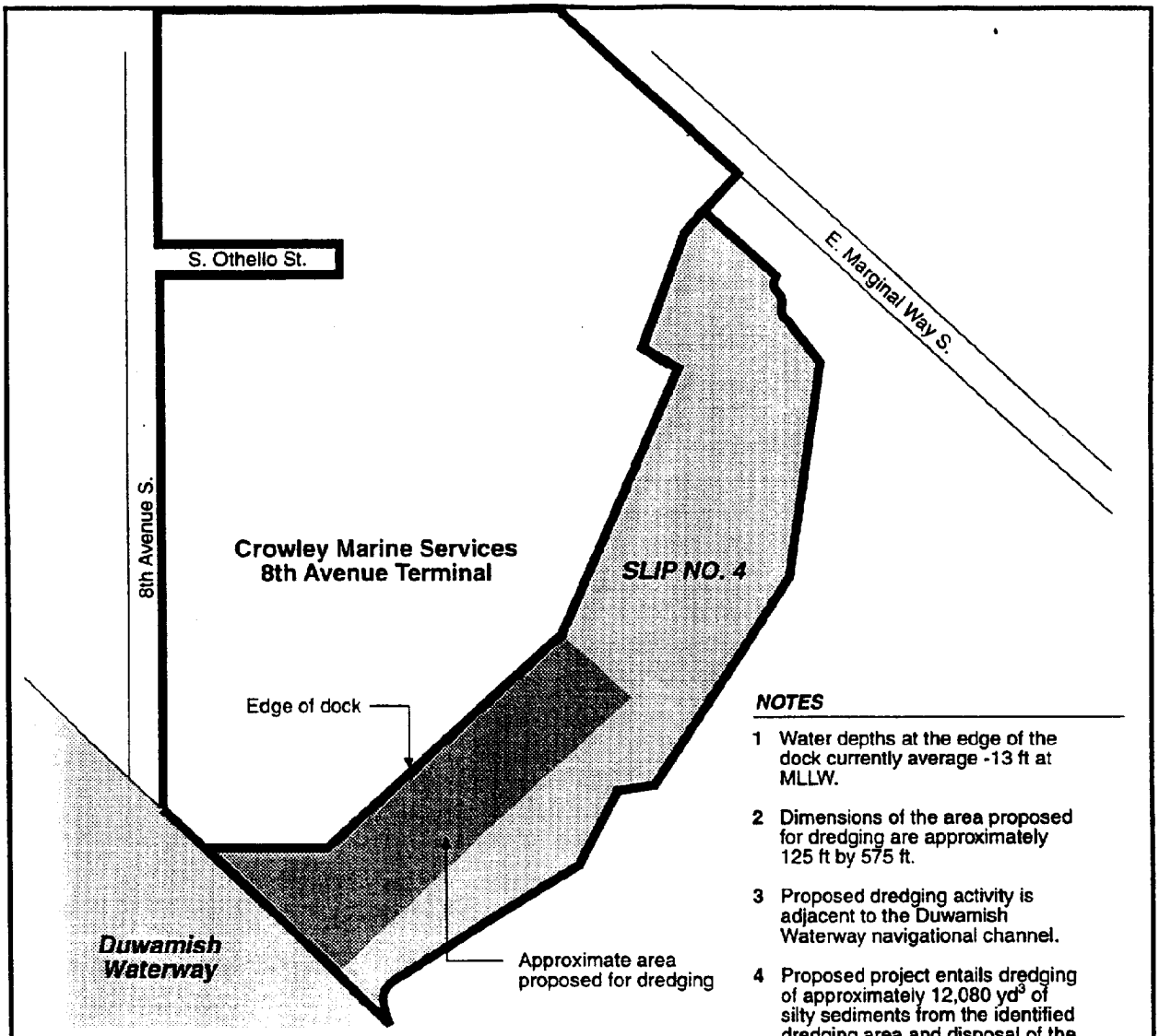
APPLICATION BY:
Crowley Marine Services

SHEET: DATE: 03/29/95

C483-09-01 03/29/95

KCSlip4 59524

SEA425823



NOTES

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4 Proposed project entails dredging of approximately 12,080 yd^3 of silty sediments from the identified dredging area and disposal of the material at either an approved PSDDA open-water disposal site or an upland disposal site, depending on the results of chemical and biological testing.

LEGEND

Property or Slip No. 4 boundary

ADJACENT PROPERTY OWNERS OR LESSEES:

1 Markey Machinery Co., Inc.
7266 8th Ave. S.
Seattle, WA 98108

2 Puget Sound Freight Lines
3720 Airport Way S.
Seattle, WA 98108

3 Boeing Aircraft Co., Inc.
7755 E. Marginal Way S.
Seattle, WA 98108

4 Evergreen Marine Leasing
First Interstate Bank
P.O. Box 160-MS-247
Seattle, Wa 98111

Figure 2. Plan view.

Crowley Marine Services
8th Avenue Terminal
7400 8th Ave. S.
Seattle, WA 98108

PROPOSED DREDGING

IN: Slip No. 4, Duwamish Waterway

AT: Seattle

COUNTY OF: King STATE: WA

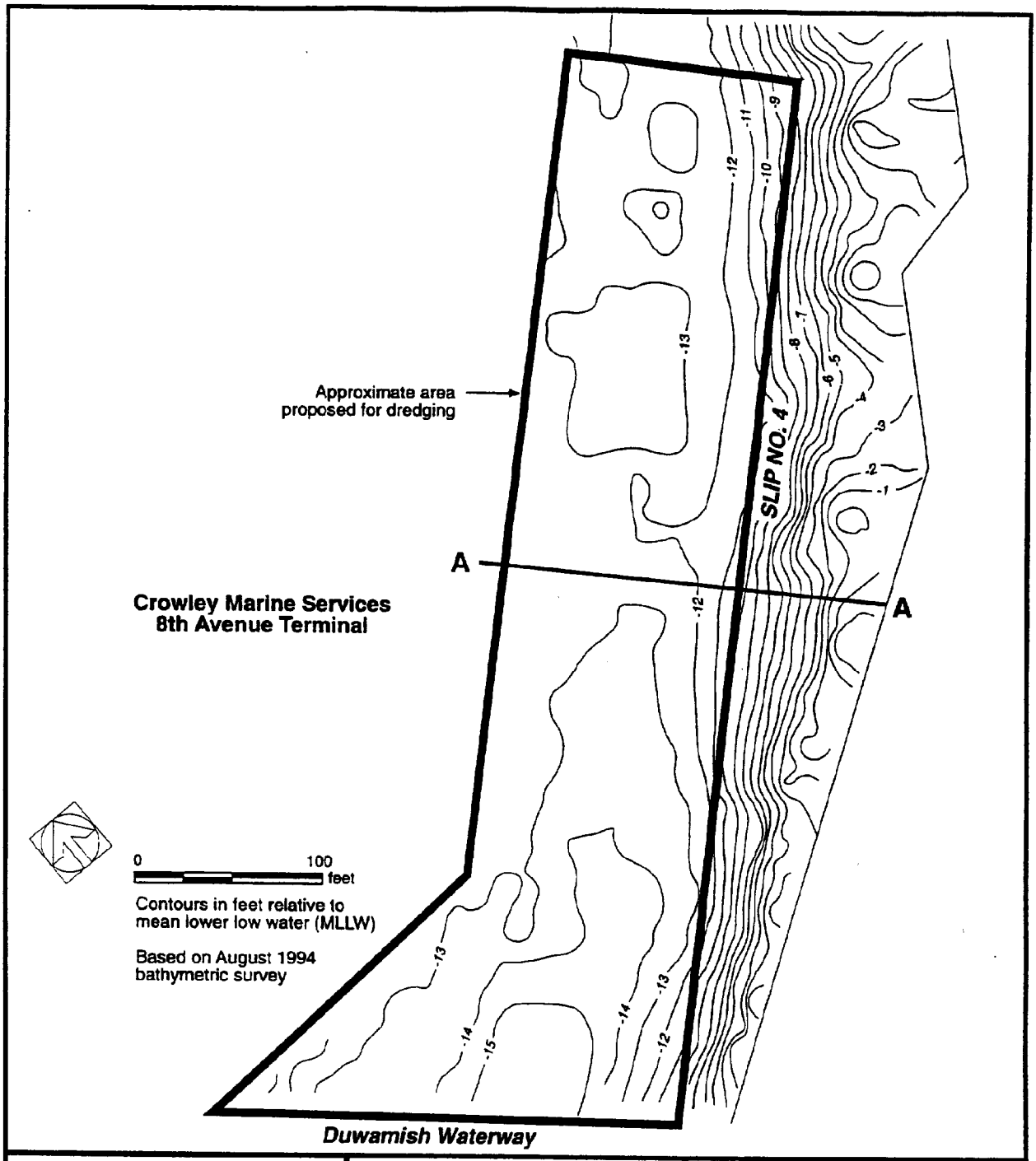
APPLICATION BY:
Crowley Marine Services

SHEET: DATE: 03/29/95

C483-09-01 03/29/95

KCSlip4 59525

SEA425824



ADJACENT PROPERTY OWNERS OR LESSEES:

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   Seattle, WA 98108
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   3720 Airport Way S.
   Seattle, WA 98108
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   7755 E. Marginal Way S.
   Seattle, WA 98108
4. Evergreen Marine Leasing
   First Interstate Bank
   P.O. Box 160-MS-247
   Seattle, Wa 98111

Figure 3.
Approximate area proposed for dredging.

Crowley Marine Services
8th Avenue Terminal
7400 8th Ave. S.
Seattle, WA 98108

PROPOSED DREDGING

IN: Slip No. 4, Duwamish Waterway

AT: Seattle

COUNTY OF: King STATE: WA

APPLICATION BY:
Crowley Marine Services

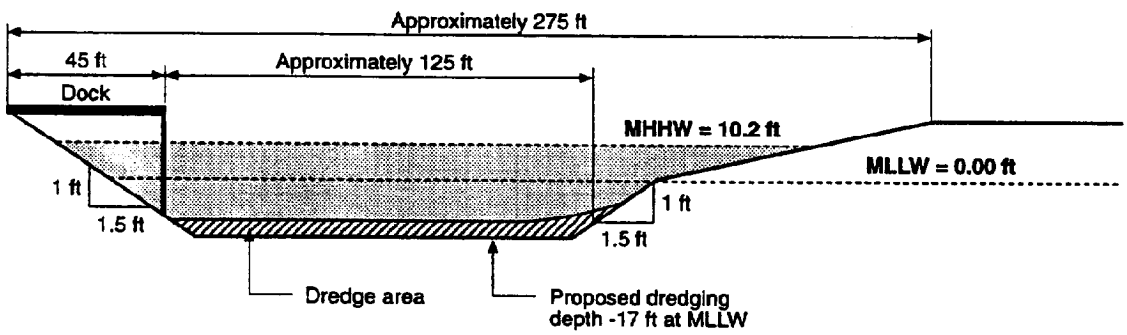
SHEET: DATE: 03/29/95

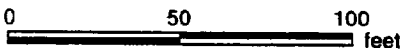
C483-09-01 03/29/95

KCSlip4 59526

SEA425825

SECTION A-A





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   Seattle, WA 98108
4. Evergreen Marine Leasing
   First Interstate Bank
   P.O. Box 160-MS-247
   Seattle, Wa 98111

Figure 4.
Cross section view.

Crowley Marine Services
8th Avenue Terminal
7400 8th Ave. S.
Seattle, WA 98108

PROPOSED DREDGING

IN: Slip No. 4, Duwamish Waterway

AT: Seattle

COUNTY OF: King STATE: WA

APPLICATION BY:
Crowley Marine Services

SHEET: DATE: 03/29/95

C483-09-01 03/29/95

KCSlip4 59527

SEA425826

Appendix B

PSDDA Parameters and Methods

TABLE B–1. TESTING PARAMETER, PREPARATION METHOD, ANALYTICAL METHOD, SEDIMENT METHOD DETECTION LIMIT, PSDDA SCREENING LEVELS, MAXIMUM LEVELS, AND BIOACCUMULATION TRIGGER LEVELS

Parameter	Prep Method	Analysis Method[a]	Sediment MDL[b]	PSDDA[b] SL	PSDDA[b] BT	PSDDA[b] ML
Conventionals						
Total solids (percent)	--	Pg.17 (1)	0.1	--	--	--
Total volatile solids (percent)	--	Pg.20 (1)	0.1	--	--	--
Total organic carbon (percent)	--	Pg.23 (1,2)	0.1	--	--	--
Total sulfides (mg/kg)	--	Pg.32 (1)	1	--	--	--
Ammonia (mg/kg)	--	Plumb 1981 (3)	1	--	--	--
Grain size	--	Modified ASTM with hydrometer	--	--	--	--
Metals (ppm)						
Antimony	APNDX D (4)	GFAA (5)	2.5	20	146	200
Arsenic	APNDX D (4)	GFAA (5)	2.5	57	507.1	700
Cadmium	APNDX D (4)	GFAA (5)	0.3	0.96	--	9.6
Copper	APNDX D (4)	ICP (6)	15.0	81	--	810
Lead	APNDX D (4)	ICP (6)	0.5	66	--	660
Mercury	MER (7)	7471 (7)	0.02	0.21	1.5	2.1
Nickel	APNDX D (4)	ICP (6)	2.5	140	1,022	--
Silver	APNDX D (4)	GFAA (5)	0.2	1.2	4.6	6.1
Zinc	APNDX D (4)	ICP (6)	15.0	160	--	1,600
Organics (ppb)						
LPAH						
Naphthalene	3550 (8)	8270 (9,10)	20	210	--	2,100
Acenaphthylene	3550 (8)	8270 (9,10)	20	64	--	640
Acenaphthene	3550 (8)	8270 (9,10)	20	63	--	630
Fluorene	3550 (8)	8270 (9,10)	20	64	--	640
Phenanthrene	3550 (8)	8270 (9,10)	20	320	--	3,200
Anthracene	3550 (8)	8270 (9,10)	20	130	--	1,300
2-Methylnaphthalene	3550 (8)	8270 (9,10)	20	67	--	670
Total LPAH				610	--	6,100
HPAH						
Fluoranthene	3550 (8)	8270 (9,10)	20	630	4,600	6,300
Pyrene	3550 (8)	8270 (9,10)	20	430	--	7,300
Benzo(a)anthracene	3550 (8)	8270 (9,10)	20	450	--	4,500
Chrysene	3550 (8)	8270 (9,10)	20	670	--	6,700
Benzofluoranthenes	3550 (8)	8270 (9,10)	20	800	--	8,000
Benz(a)pyrene	3550 (8)	8270 (9,10)	20	680	4,964	6,800
Indeno(1,2,3-cd)pyrene	3550 (8)	8270 (9,10)	20	69	--	5,200

TABLE B-1. (cont.)

Parameter	Prep Method	Analysis Method[a]	Sediment MDL[b]	PSDDA[b] SL	PSDDA[b] BT	PSDDA[b] ML
Dibenzo(a,h)anthracene	3550 (8)	8270 (9,10)	20	120	--	1,200
Benzo(ghi)perylene	3550 (8)	8270 (9,10)	20	540	--	5,400
Total HPAH				1,800	--	51,000
Chlorinated Hydrocarbons						
1,3-Dichlorobenzene	P&T (12)	8240 (11)	3.2	170	1,241	--
1,4-Dichlorobenzene	P&T (12)	8240 (11)	3.2	26	190	260
1,2-Dichlorobenzene	P&T (12)	8240 (11)	3.2	19	37	350
1,2,4-Trichlorobenzene	3550 (8)	8270 (9,10)	6	13	--	64
Hexachlorobenzene (HCB)	3550 (8)	8270 (9,10)	12	23	168	230
Phthalates						
Dimethyl phthalate	3550 (8)	8270 (9,10)	20	160	1,168	--
Diethyl phthalate	3550 (8)	8270 (9,10)	20	97	--	--
Di-n-butyl phthalate	3550 (8)	8270 (9,10)	20	1,400	10,220	--
Butyl benzyl phthalate	3550 (8)	8270 (9,10)	20	470	--	--
Bis(2-ethylhexyl)phthalate	3550 (8)	8270 (9,10)	20	3,100	13,870	--
Di-n-octyl phthalate	3550 (8)	8270 (9,10)	20	6,200	--	--
Phenols						
Phenol	3550 (8)	8270 (9,10)	20	120	876	1,200
2-Methylphenol	3550 (8)	8270 (9,10)	6	20	--	72
4-Methylphenol	3550 (8)	8270 (9,10)	20	120	--	1,200
2,4-Dimethylphenol	3550 (8)	8270 (9,10)	6	29	--	50
Pentachlorophenol	3550 (8)	8270 (9,10)	61	100	504	690
Miscellaneous Extractables						
Benzyl alcohol	3550 (8)	8270 (9,10)	6	25	--	73
Benzoic acid	3550 (8)	8270 (9,10)	100	400	--	690
Dibenzofuran	3550 (8)	8270 (9,10)	20	54	--	540
Hexachloroethane	3550 (8)	8270 (9,10)	20	1,400	10,220	14,000
Hexachlorobutadiene	3550 (8)	8270 (9,10)	20	29	212	290
N-Nitrosodiphenylamine	3550 (8)	8270 (9,10)	12	28	161	220
Volatile Organics						
Trichloroethene	P&T (12)	8240 (11)	3.2	160	1,168	1,600
Tetrachloroethene	P&T (12)	8240 (11)	3.2	14	102	210
Ethylbenzene	P&T (12)	8240 (11)	3.2	10	27	50
Total Xylene	P&T (12)	8240 (11)	3.2	12	--	160
Pesticides						
Total DDT	--	--	--	6.9	50	69
p,p'-DDE	3540 (13)	8080 (13)	2.3	--	--	--
p,p'-DDD	3540 (13)	8080 (13)	3.3	--	--	--

TABLE B-1. (cont.)

Parameter	Prep Method	Analysis Method[a]	Sediment MDL[b]	PSDDA[b] SL	PSDDA[b] BT	PSDDA[b] ML
p,p'-DDT	3540 (13)	8080 (13)	6.7	--	--	--
Aldrin	3540 (13)	8080 (13)	1.7	10	37	--
Chlordane	3540 (13)	8080 (13)	1.7	10	37	--
Dieldrin	3540 (13)	8080 (13)	2.3	10	37	--
Heptachlor	3540 (13)	8080 (13)	1.7	10	37	--
Lindane	3540 (13)	8080 (13)	1.7	10	--	--
Total PCBs	3540 (13)	8080 (13)	67	130	38[c]	2,500

Note: BT - bioaccumulation trigger
MDL - method detection limit
ML - maximum level
PCB - polychlorinated biphenyl
SL - screening level

[a] Numbers in parentheses correspond to the references below.

[b] Dry-weight basis.

[c] Total PCBs BT value in ppm carbon-normalized.

1. PSEP. 1986. Recommended protocols for measuring conventional sediment variables in Puget Sound. U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Puget Sound Estuary Program, Seattle, WA.

2. Bragdon-Cook, K. 1993. Recommended methods for measuring TOC in sediments. Clarification Paper. Puget Sound Dredged Disposal Analysis Annual Review, May, 1993.

3. Plumb, R.H., Jr. 1981. Procedure for handling and chemical analysis of sediment and water samples. Technical Report EPA/CE-81-1. U.S. Environmental Protection Agency and U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

4. PSEP. 1989. Recommended protocols for measuring metals in Puget Sound water, sediment and tissue samples. U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Puget Sound Estuary Program, Seattle, WA.

5. U.S. EPA. 1986. Test methods for evaluating solid waste (SW-846): physical/chemical methods. Graphite furnace atomic absorption (GFAA) spectrometry. U.S. Environmental Protection Agency, Office of Solid Waste, Washington, DC.

6. U.S. EPA. 1986. Test methods for evaluating solid waste (SW-846): physical/chemical methods. Inductively coupled plasma (ICP) emission spectrometry. U.S. Environmental Protection Agency, Office of Solid Waste, Washington, DC.

7. U.S. EPA. 1986. Test methods for evaluating solid waste (SW-846): physical/chemical methods. Mercury digestion and cold vapor atomic absorption (CVAA) spectrometry - Method 7471. U.S. Environmental Protection Agency, Office of Solid Waste, Washington, DC.

8. U.S. EPA. 1986. Test methods for evaluating solid waste (SW-846): physical/chemical methods. Sonication Extraction of sample solids - Method 3550 (Modified). U.S. Environmental Protection Agency, Office of Solid Waste, Washington, DC. (Method is modified to add matrix spikes before the dehydration step rather than after the dehydration step.)

9. U.S. EPA. 1986. Test methods for evaluating solid waste (SW-846): physical/chemical methods. GCMS capillary column - Method 8270. U.S. Environmental Protection Agency, Office of Solid Waste, Washington, DC.

TABLE B-1. (cont.)

10. PSEP. 1989. Recommended guidelines for measuring organic compounds in Puget Sound sediment and tissue samples. U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Puget Sound Estuary Program, Seattle, WA.

11. U.S. EPA. 1986. Test methods for evaluating solid waste (SW-846): physical/chemical methods. GCMS analysis - Method 8240. U.S. Environmental Protection Agency, Office of Solid Waste, Washington, DC.

12. U.S. EPA. 1986. Test methods for evaluating solid waste (SW-846): physical/chemical methods. Purge and trap extraction and GCMS analysis - Method 8240. U.S. Environmental Protection Agency, Office of Solid Waste, Washington, DC.

13. U.S. EPA. 1986. Test methods for evaluating solid waste (SW-846): physical/chemical methods. Soxhlet extraction and Method 8080. U.S. Environmental Protection Agency, Office of Solid Waste, Washington, DC.

Appendix C

QA2 Data Requirements

QA2 DATA REQUIREMENTS

CHEMICAL VARIABLES

Organic Compounds

The following documentation is required for organic compounds:

- a cover letter referencing or describing the procedure used and discussing any analytical problems;
- reconstructed ion chromatograms for gas chromatography/mass spectrometry (GC/MS) analyses for each sample;
- mass spectra of detected target compounds (GC/MS) for each sample and associated library spectra;
- gas chromatography/electron capture detection and/or gas chromatography/flame ionization detection chromatograms for each sample;
- original data quantification reports for each sample;
- a calibration data summary reporting calibration range used (and decafluorotriphenylphosphine [DFTPP] and bromofluorobenzene [BFB] spectra and quantification report for GC/MS analyses);
- final dilution volumes, sample size, wet-to-dry ratios, and instrument detection limit;
- analyte concentrations with reporting units identified (to two significant figures unless otherwise justified);
- quantification of all analytes in method blanks (ng/sample);
- method blanks associated with each sample;
- recovery assessments and a replicate sample summary (laboratories should report all surrogate spike recovery data for each sample; a statement of the range of recoveries should be included in reports using these data); and
- data qualification codes and their definitions.

Metals

For metals, the data report package for analyses of each sample should include the following:

- tabulated results in units as specified for each matrix in the analytical protocols, validated and signed in original by the laboratory manager;
- any data qualifications and explanation for any variance from the analytical protocols;
- results for all of the quality assurance and quality control (QA/QC) checks initiated by the laboratory; and
- tabulation of instrument and method detection limits.

All contract laboratories are required to submit metals results that are supported by sufficient backup data and quality assurance results to enable independent quality assurance reviewers to conclusively determine the quality of the data. The laboratories should be able to supply legible photocopies of original data sheets with sufficient information to unequivocally identify the following:

- calibration results;
- calibration and preparation blanks;
- samples and dilutions;
- duplicates and spikes; and
- any anomalies in instrument performance or unusual instrumental adjustments.

TOXICITY TESTS

Amphipod Mortality Test

The following data should be reported by all laboratories performing this toxicity test:

- daily water quality measurements during testing (e.g., dissolved oxygen, temperature, salinity, pH) (plus ammonia and sulfides at test initiation and termination);
- daily emergence for each beaker and the 10-day mean and standard deviation for each treatment;
- 10-day survival in each beaker and the mean and standard deviation for each treatment;
- interstitial salinity values of test sediments;

- 96-hour LC_{50} values with reference toxicants; and
- any problems that may have influenced data quality.

Sediment Larval Test

The following data should be reported by all laboratories performing this toxicity test:

- daily water quality measurements (e.g., dissolved oxygen, temperature, salinity, pH) (plus ammonia and sulfides at test initiation and termination);
- individual replicate and mean and standard deviation data for larval survival at test termination;
- individual replicate and mean and standard deviation data for larval abnormalities at test termination;
- 48-hour LC_{50} and EC_{50} values with reference toxicants; and
- any problems that may have influenced data quality.

Neanthes Growth Test

The following data should be reported by all laboratories performing this toxicity test:

- Water quality measurements at test initiation and termination and every 3 days during testing (e.g., dissolved oxygen, temperature, salinity, pH) (plus ammonia and sulfides at test initiation and termination);
- 20-day survival in each beaker and the mean and standard deviation for each treatment;
- initial biomass;
- final biomass (20-day) for test, reference, and control treatments;
- 96-hour LC_{50} values with reference toxicants; and
- any problems that may have influenced data quality.

Appendix D

DAIS Data Checklist

TABLE D-1. DAIS DATA CHECKLIST

(shaded areas indicate required data)

	Test Sediment	Reference Sediment	Control Sediment	Seawater Control
Sample Locations and Compositing				
Latitude and longitude (to nearest 0.1 sec)	■	■		
NAD 1927 or 1983	■	■		
USGS Benchmark ID	■			
Station name (e.g., Carr Inlet)		■	■	■
Water depth (corrected to MLLW)	■	■	■	■
Drawing showing sampling locations and ID numbers	■			
Compositing scheme (sampling locations/depths for composites)	■			
Sampling method	■	■		
Sampling dates	■	■	■	■
Estimated volume of dredged material represented by each DMMU	■			
Positioning method	■	■		
Sediment Conventionals				
Preparation and analysis methods	■	■		
Sediment conventional data and QA/QC qualifiers	■	■		
QA qualifier code definitions	■	■		
Triplicate data for each sediment conventional for each batch	■			
Units (dry weight except total solids)	■	■		
Method blank data (sulfides, ammonia, TOC)	■			
Method blank units (dry weight)	■			
Analysis dates (sediment conventionals, blanks, TOC CRM)	■	■		
TOC CRM ID	■			
TOC CRM analysis data	■			
TOC CRM target values	■			

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	Test Sediment	Reference Sediment	Control Sediment	Seawater Control
Grain size analysis				
Fine grain analysis method				
Analysis dates				
Triplicate for each batch				
Grain size data (complete sieve and phi size distribution)				

	Metals	Semivolatiles	Pesticides/ PCBs	Volatiles
Chemicals of Concern Analysis Data				
Extraction/digestion method				
Extraction/digestion dates (test sediment, blanks, matrix spike, reference material)				
Analysis method				
Data and QA qualifier included for:				
Test sediments				
Reference materials including 95 percent confidence interval (each batch)				
Method blanks (each batch)				
Matrix spikes (each batch)				
Matrix spike added (dry weight basis)				
Replicates (each batch)				
Units (dry weight)				
Method blank units (dry weight)				
QA/QC qualifier definitions				
Surrogate recovery for test sediment, blank, matrix spike, reference material				
Analysis dates (test sediment, blanks, matrix spike, reference material)				

	Each Batch	Test Sediment	Reference Sediment	Control Sediment
Amphipod Mortality and Emergence				
Species name				
Mortality and emergence:				
Start date				
Daily emergence (for 10 days)				
Survival at end of test				
Number failing to rebury at end of test				
Positive control:				
Toxicant used				
Toxicant concentrations				
Exposure time				
LC_{50}				
LC_{50} method of calculation				
Start date				
Survival data				
Water quality measurement methods:				
Dissolved oxygen				
Ammonia				
Interstitial salinity				
Sulfide				
Water salinity				
Water quality:				
Temperature (Day 0 through Day 10)				
pH (Day 0 through Day 10)				
Dissolved oxygen (Day 0 through Day 10)				
Water salinity (Day 0 through Day 10)				
Sulfide (Day 0, Day 10)				
Ammonia (Day 0, Day 10)				
Interstitial water salinity (Day 0)				

	Each Batch	Test Sediment	Reference Sediment	Seawater Control
Sediment Larval Mortality and Abnormality				
Species name				
Toxicity test parameters:				
Inoculation time (hrs)				
Exposure time (hrs)				
Stocking beaker density (No/mL)				
Stocking aliquot size (mL)				
Aeration (yes/no)				
Mortality and abnormality:				
Start date				
Initial count (minimum of five 10-mL aliquots)				
Final count:				
Aliquot size (mL)				
Number normal per aliquot				
Number abnormal per aliquot				
Water quality measurement methods:				
Dissolved oxygen				
Ammonia				
Sulfide				
Water salinity				
Water Quality:				
Temperature (daily)				
pH (daily)				
Dissolved oxygen (daily)				
Water salinity (daily)				
Sulfide (initial and final)				
Ammonia (initial and final)				
Positive Control:				
Toxicant used				
Toxicant concentrations				

	Each Batch	Test Sediment	Reference Sediment	Seawater Control
Sediment Larval Mortality and Abnormality (cont.)				
Exposure time				
EC_{50}				
EC_{50} method of calculation				
Start date				
Normal/abnormal counts				
***Neanthes* 20-Day Growth Test**				
Starting age (in days post-emergence)				
Food type				
Quantity (mg/beaker/interval)				
Feeding interval (hrs)				
Biomass and mortality:				
Start date				
Initial counts and weights (mg dry weight)				
Number of survivors and final weights (mg dry weight)				
Positive control:				
Toxicant used				
Toxicant concentration				
Exposure time				
LC_{50}				
LC_{50} method of calculation				
Start date				
Survival data				
Water quality measurement methods:				
Dissolved oxygen				
Ammonia				
Interstitial salinity				
Sulfide				

	Each Batch	Test Sediment	Reference Sediment	Control Sediment
***Neanthes* 20-Day Growth Test (cont.)**				
Water salinity				
Water quality:				
Temperature (Days 0, 3, 6, 9, 12, 15, 18, 20)				
pH (Days 0, 3, 6, 9, 12, 15, 18, 20)				
Dissolved oxygen (Days 0, 3, 6, 9, 12, 15, 18, 20)				
Water salinity (Days 0, 3, 6, 9, 12, 15, 18, 20)				
Interstitial salinity (Day 0)				
Sulfide (initial and final)				
Ammonia (initial and final)				

Note: CRM - certified reference material
DMMU - dredged material management unit
MLLW - mean lower low water
PCB - polychlorinated biphenyl
QA/QC - quality assurance and quality control